REPORT OF

Twenty-Seventh Annual

DATE GROWERS' INSTITUTE

APRIL 29, 1950

HELD IN

COACHELLA VALLEY

CALIFORNIA

Twenty-Seventh Annual

DATE GROWERS' INSTITUTE

HELD IN

COACHELLA VALLEY

CALIFORNIA

APRIL 29, 1950

VOLUME 27

CHAIRMAN MORNING SESSION H. B. Richardson

CHAIRMAN AFTERNOON SESSION James C. Wood

Table of Contents

VOLUME 27

Published by

DATE GROWERS' INSTITUTE

Coachella Valley, California

November 1, 1950

The Date Growers' Institute, a non-profit, educational organization devoted to furthering the knowledge of date culture, is now in its twenty-seventh year. Proceedings of each Institute have been published, and may be purchased in complete sets, or by separate copies. Direct all inquiries to the Secretary.

27th Annual Date Growers' Institute

April 29, 1950

Chairman Morning Session: H. B. Richardson, Extension Specialist in Viticulture, College of Agriculture, Davis, California

Chairman Afternoon Session: James C. Wood, President Arizona Date Institute, and Date Grower

INTRODUCTION

Hilton B. Richardson

Extension Specialist in Viticulture, College of Agriculture, Davis, California and
Formerly Farm Advisor in Riverside County

I would like first to express to you my sincere appreciation of the honor of presiding at the morning session of this, the 27th Annual Date Growers Institute. We, of the Agricultural Extension Service, of the University of California, are particularly proud of this group of Southern California date growers. For 27 years, we have watched your work on the problems of your industry through the means of this institute. The date Institute Committee composed of many different groups of thought in their yearly program planning meetings have sat around the table and objectively formulated interesting programs.

These programs and talks on many subjects have always been directed toward giving the date grower wider and better understanding of the Date Industry and its problems. Looking back over the published proceedings of 26 previous years we see many names of prominent farmers in this new horticultural field. These farmers have presented their views and experiences which make up a valuable part of the published proceedings. We also see names of prominent federal and state research people, all contributing their bit toward the solution of the date growers problems.

Publication of the yearly proceedings has constituted a permanent written record of these many yearly deliberations. These proceedings are available for present and future date growers to glean information and guidance on the problems of the industry.

During the early 1930s, there was a serious discussion as to the discontinuance of the Institute. The decision to continue prevailed and the Institute survived. I think all of us now are very pleased that the uninterrupted yearly meetings were carried on. There were times when the program material was very scarce and money for publication was slim but somehow Mr. Green, the editor and publisher of the Coachella Valley Submarine paper, was paid, and the proceedings published and the Institute went on. Our meeting places were not so good in the early days. When I arrived on the scene we met in the Roosevelt School. Sort of a hot place. Chairs squeaked. And occasionally we had long talks, much given over to detail. We thought we couldn't survive, but we did and the Institute went on.

There was also a time when much debate was had on marketing. Ideas were many, and many thought the Institute would go to blazes if we talked about the marketing of dates which might go against some individual's pet ideas. But the committee included many marketing discussions and the Institute survived. There was a time when Dr. Wellman of the Giannini Foundation of the University of California told us that we would in a few years hence again receive low prices for our products. Did we believe that? No, we did not. It made us sort of mad. Today, we would have to concede that he was right.

The Institute has survived much adversity and criticism, but holding to the concept that the Institute should be and will be kept a nonprofit growers educational yearly event has made it strong over the years and I am sure it will continue to serve a long and useful purpose.

I have been particularly happy these last 15 years to have lived and worked among the farmers of Riverside County. You have taught me many lessons and I hope that I have been helpful on your problems. Time has passed. It seems only yesterday that I came to this county. My official duties as Farm Advisor have been terminated here in Riverside County but I am still a member of the State Extension Staff and greatly interested in the welfare of the agriculture of this state. I am sure that the men in the local extension office will keep up the good work, improve on the old so that the Institute should go ahead accomplishing its task as a worthwhile, educational medium for the dissemination of information to date growers.

PROGRESS REPORT ON CONTROL OF DATE INSECTS AND THE DATE MITE[1]

L. E. Vincent and D. L. Lindgren[2]

University of California Citrus Experiment Station, Riverside

NITIDULID BEETLES

Studies on the control of date insects and the date mite were begun in 1945 by the University of California Citrus Experiment Station, Riverside, in cooperation with the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine. Since these studies were initiated, it has been determined that there are four predominant species of nitidulid beetles infesting dates, namely, the corn sap beetle, *Carpophilus dimidiatus* (Fab.); the dried-fruit beetle, *C. hemipterus* (L.); the pineapple beetle, *Urophorus humeralis* (Fab.); and the yellowish

nitidulid *Haptoncus luteolus* (Er.) (2).

The life history of these beetles has been determined under controlled laboratory conditions at temperatures approximating the means of the monthly temperatures in the Coachella Valley from April to November, the period during which dates mature (4). A considerable amount of information on the biology of these insects in the field has also been determined; this includes their flight habits, the activity of the adult beetles relative to temperature, the length of time larvae can withstand submersion, pupation habits, and activity and development of larvae, pupae, and adults during the winter months (1, 2).

After the biology of these beetles had been determined, a method of control was sought. Flooding by irrigation, chemical treatment of the soil to control the immature forms, spraying of the date overlay, and garden sanitation were tried (1, 2, 3, 4). All these measures helped to reduce the beetle population, but the beetles still were found in the date bunches. This suggested that they were moving into the bunches from the surrounding area, and it was concluded that the best method of control would be one or more properly timed applications of dusts to the date bunch.

A year ago laboratory results were reported (4) as indicating that lindane, chlordane, parathion, aldrin (118), and dieldrin (497) not only gave excellent initial kill, but also killed the nitidulid beetles that came in contact with any of these materials for several weeks to a month or more after application. Because of the low beetle population in 1948, the results of insecticidal tests during that season were inconclusive and failed to give a clear-cut indication as to the effectiveness of the dust treatment. These tests were consequently repeated in greater detail during the 1949 season, with particular emphasis on the timing of the dustings. It is with these tests that this progress report is concerned.

Experimental Procedure. Field tests in 1949 were conducted on two varieties of dates, Khadrawi and Deglet Noor. The Khadrawi plot was located at Indio; the two Deglet Noor plots were located at Indio (plot I) and at Thermal (plot II). Deglet Noor plot I was interplanted with grapefruit and was maintained under conditions of higher moisture than plot II, which had no interplanting.

The Khadrawi variety was chosen as a representative of the soft or invert-sugar group. The following insecticidal dusts were applied on the Khadrawi plot: 1 per cent and 2.5 per cent dieldrin, 2 per cent lindane, 1 per cent parathion + 1 per cent dieldrin mixture, and 1 per cent lindane + 1 per cent dieldrin mixture.

The Deglet Noor variety was chosen as a representative of the cane-sugar group. The following dusts were applied to both Deglet Noor plots: 1 per cent and 2.5 per cent dieldrin, 2 per cent parathion, 1 per cent parathion + 1 per cent dieldrin mixture, and 1 per cent lindane + 1 per cent dieldrin mixture.

All dusts were applied with Root hand dusters, and coverage was as thorough and even as was possible with this type of applicator, although heavier than would be obtained with conventional power equipment. All bunches, including controls, were bagged prior to dust treatment, as better dust coverage is obtained in this way and the dust is prevented from drifting onto the other bunches. Control bunches were interspersed among treated bunches on the same palm.

In the Khadrawi plot each dust was applied five times on different bunches at intervals of one, two, three, four, and five weeks prior to

Table 1.—Results of Various Insecticidal Dusts on Insect Infestation in Khadrawi and Deglet Noor Dates

Treatment	Percentage of dates		Number of beetles present on final examination	
	Infested with beetles	Spoiled by fungus	Alive	Dead
Khadrawi Plot				
None (control)	3.2	0.20	201	0
1% Dieldrin	0.1	0.30	0	15
2.5% Dieldrin	2.1	0.06	0	2
2% Lindane	0.0	0.10	0	0
1% Lindane + 1% dieldrin	0.8	0.10	0	1
1% Parathion + 1% dieldrin	0.4	0.00	0	53
Deglet Noor Plot I				
None (control)	20.5	20.5	2623	0
1% Dieldrin	6.3*	14.8	183	415
2.5% Dieldrin	2.8*	10.4	44	143
2% Parathion	5.6*	24.8	41	848
1% Parathion + 1% dieldrin	3.4*	14.8	16	127
1% Lindane + 1% dieldrin	2.8*	15.9	73	67
Deglet Noor Plot II				
None (control)	8.0	10.3	810	0
1% Dieldrin	0.4†	9.0	0	6
2.5% Dieldrin	1.6‡	19.6	1	69
2% Parathion	1.9‡	13.2	1	91
1% Parathion + 1% dieldrin	0.9*	19.3	3	33
1% Lindane + 1% dieldrin	1.0*	11.3	3	12

* Significant at 1 per cent level.
† Significant at 2 per cent level.
‡ Significant at 5 per cent level.

1. Paper No. 645, University of California Citrus Experiment Station, Riverside, California.

2. The writers wish to express their appreciation to T. R. Brown, J. H. Lang, L. J. Anderson, the U. S. Date Garden, E. G. Gebhardt, and N. R. Jarvis for their cooperation in making experimental plots available, and to Julius Hyman & Company, Pennsylvania Salt Manufacturing Company, and the American Cyanamid Company for supplying insecticides for experimental purposes.

the first picking. No bunch received more than one treatment; thus one bunch received a treatment five weeks prior to the first picking, another bunch four weeks prior to picking, and so on. This same procedure was followed in both Deglet Noor plots, except that each dust except parathion was applied four times at intervals of one, two, three, and four weeks prior to the first picking. Parathion was applied at intervals of one, two, and three weeks prior to the first picking.

Picking was not done in the accepted manner. Instead, a random sample of 50 mature fruits was picked from each bunch at each picking. The remainder were left on the bunch to see if they would become infested. This procedure gave an indication of the residual toxicity of the insecticidal dusts. Six pickings were made in the Khadrawi plot over a period of 42 days. Four pickings were made in each of the two Deglet Noor plots over a period of 44 days for Deglet Noor plot I and 34 days for Deglet Noor plot II.

After each picking, the fruit was brought to the Citrus Experiment Station, where each fruit was cut open to determine infestation. Beetle counts were made to determine the proportion of the four species present and the number of living and/or dead beetles.

RESULTS. The 1949 seasonal results of all pickings of the Khadrawi and Deglet Noor plots are shown in table 1. The percentage of beetle-infested fruit varied from garden to garden. In the early-maturing Khadrawi plot, infestation of the control fruit was low (3.2 per cent). In the later-maturing Deglet Noor plots there was a substantial increase, infestation of the control fruit being 8 per cent in plot II, a noninterplanted garden, and 20.5 per cent in plot I, an interplanted garden.

Except in the Khadrawi plot, the percentage of spoiled fruit closely paralleled that of beetle-infested fruit found in the controls. This factor is of particular significance, because, as previously stated (3), there is a positive correlation between the degree of fungus spoilage and of insect infestation. Although the percentage of spoiled fruit in the two Deglet Noor plots remained high in the treated bunches, the percentage of beetle-infested fruit was significantly reduced in all cases.

The Khadrawi plot was low, both in beetle-infested fruits and in spoiled fruits. The results were not very evident, probably because of the low beetle population. Much of the infestation was due to the sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), which was not affected by the treatments, live beetles being found in the treated bunches.

The counts of live and dead nitidulid beetles in all three plots showed very interesting results (table 1). Although the number of beetles in the control fruit in the Khadrawi plot was low in comparison with the number in the Deglet Noor plots, no live beetles were found in the treated bunches, and a relatively small number of dead beetles were found. In Deglet Noor plot II a large number of beetles were found in the control fruit, but no live beetles were found in the fruit of one treatment, and in that of the remaining treatments only fruit, but no live beetles were found Deglet Noor plot I, an interplanted garden receiving frequent irrigations, the number of beetles found in the control fruit was very high. Conditions in this garden were ideal for beetle development: the spoilage factor was high, and this served to attract beetles, a food source being constantly available from the June drop forward; moisture conditions were ideal for the development of these beetles, and the high temperature (table 2) allowed four to six generations of beetles to develop from June to fruit harvest.

Since one female beetle is capable of laying as many as 500 eggs, a tremendous population of beetles may result from even a single pair of individuals in a period of two or three months, under favorable conditions. In Deglet Noor plot I, a very high population existed by the time of the first picking. Although a few beetles managed to enter fruit in the treated bunches without being killed, the number that were killed greatly exceeded those that were not. The average numbers of beetles per fruit in the two Deglet Noor plots are shown in table 3.

The importance of the timing of the dust application is indicated by the data in table 4. In Deglet Noor plot I, a 1 per cent dieldrin dust applied four weeks prior to the first picking gave a reduction in beetle infestation of 31 per cent in the control to 0.8 per cent in the treated fruit. The second application, applied three weeks prior to the first picking, gave a reduction in infestation of 31 per cent in the control to 9.7 per cent in the treated. The third and fourth applications, applied two weeks and one week, respectively, prior to the first picking, were applied too late to give control. The other dust treatments follow the same pattern exhibited by 1 per cent dieldrin. This suggests that the beetles were beginning to infest the dates in progres-

Table 2.—Average Monthly Temperatures at Indio, California, 1949*

Month	Degrees F.	Month	Degrees F.
January	44.7	July	90.0
February	53.4	August	90.0
March	62.5	September	86.9
April	74.2	October	72.0
May	77.0	November	68.5
June	86.7	December	53.0

*Climatological Data, California Section, U. S. Weather Bureau, Vol. 53, 1949.

Table 3.—Results of Various Insecticidal Dusts on Nitidulid Beetles in Deglet Noor Dates

Treatment	Average number of beetles per fruit			
	Deglet Noor Plot I		Deglet Noor Plot II	
	Alive	Dead	Alive	Dead
None (control)	1.60	0.00	1.000	0.000
1% Dieldrin	0.10	0.20	0.000	0.009
2.5% Dieldrin	0.02	0.08	0.001	0.090
2% Parathion	0.03	0.70	0.001	0.100
1% Parathion + 1% dieldrin	0.01	0.09	0.003	0.040
1% Lindane + 1% dieldrin	0.04	0.04	0.003	0.010

Table 4.—Percentage of Beetle Infestation in Dates of Deglet Noor Plot I, in Relation to Timing of Applications of 1 Per Cent Dieldrin Dust and Date of Picking*

Dust application, 1949	Picking date, 1949			
	First, Sept. 27	Second, Oct. 11	Third, Oct. 26	Fourth, Nov. 9
None (control)	31.0	30.4	13.0	15.8
First, Aug. 31	0.8	5.8	1.1	0.0
Second, Sept. 7	9.7	10.7	3.7	5.2
Third, Sept. 14	37.5	8.5	7.8	0.0
Fourth, Sept. 21	17.5	11.8	9.7	2.9

*Results of other dust treatments approximate these figures.

sively increasing numbers after the application of the first dust, prior to the first picking. It can also be seen from table 4 that, in general, the infestation was reduced with each successive picking as the bunch was thinned and the rotting fruit removed. In Deglet Noor plot II, the beetle population was declining at the time the fruit was maturing; consequently, no results were obtained in this plot with reference to timing of the dust application.

Discussion. The 1949 tests gave very encouraging results on the control of the nitidulid beetles infesting dates. It must be remembered, however, that a heavier deposit was applied by the hand dusters than would be obtained with conventional power equipment. All the dusts were effective in their initial toxicity, and all exhibited high residual toxicity to the nitidulid beetles under temperatures found in the Coachella Valley (table 2).

Laboratory tests have shown that dieldrin gives longer residual action under Coachella Valley temperatures than any other compound yet tested. It is slower-acting in its toxic effect than either parathion or lindane. For this reason, two mixtures were used in the 1949 tests, namely, parathion-dieldrin and lindane-dieldrin. The parathion and lindane were used to obtain immediate knockdown, whereas the dieldrin was used for its long residual toxicity, which would continue to be effective after the parathion and lindane had lost their toxicity. Table 1 shows that these two mixtures gave the most significant results in Deglet Noor plot II and were comparable with the other treatments in Deglet Noor plot I.

The use of lindane and chlordane is doubtful, as they have occasionally imparted an off-flavor to certain varieties of dates (3). The experimental use of chlordane has been discontinued because of the off-flavor it imparts to dates. The use of lindane on Khadrawi dates this past season definitely caused off-flavor, but the use of the lindane-dieldrin mixture did not impart an off-flavor to Deglet Noor dates. More work is necessary with lindane to determine its off-flavor characteristics on different varieties of dates. None of the other compounds used this season appeared to impart an off-flavor to either Khadrawi or Deglet Noor varieties. It is anticipated that practical trials with these dusts will be possible during the forthcoming season on an experimental basis, the dusts to be applied with the same type of power duster used to apply sulfur for date-mite control.

The use of toxic dusts, particularly those that are toxic to warm-blooded animals, creates a problem of residue. All dusts used during this past season are toxic to warm-blooded animals and may therefore prove objectionable for use on the softer varieties of dates, owing to the difficulty of removing residues from such fruits. The residue problem on Deglet Noor dates will probably be minimized by the type of washing equipment now being used.

Results of analyses conducted on Khadrawi dates that had been dusted at the rate of 40 to 60 pounds per acre with a 1 per cent parathion dust are shown in table 5. None of this fruit had been washed or processed in any way. The highest deposit was 0.2 parts per million. The tentative target tolerance is 2 parts per million (5). Apparently, parathion residue breaks down rapidly enough under the high temperatures in the Coachella Valley to warrant its continued experimental use on a larger scale. No method of analysis is as yet available for dieldrin residue.

THE DATE MITE

The date mite, *Paratetranychus simplex* (Banks), injures the date fruit by scarring the skin, thus causing it to harden, crack, and shrivel. The date mite is usually abundant by June, and a treatment is required to control this pest.

In 1949 the date mite was observed on Bermuda grass in several gardens by late April. By the first of June the mites were beginning to make their appearance in the date bunches, and by the middle of June those bunches that had not been treated were heavily infested.

Several new acaricides were tested against the date mite this past season. The results of these tests are shown in table 6. All tests were conducted on heavily infested bunches. Of the ten compounds tested, seven gave no control whatsoever. Experimental Kolo dust, which was effective for 21 days, contains 84 per cent sulfur, of which 13.5 per cent is bentonite sulfur. Four per cent di-(*p*-chlorophenyl)methylcarbinol[3] was effective for 28 days. Sulfur gave the most effective control, lasting 43 days. For maximum effectiveness, the sulfur dust must be forced up into each bunch. Complete and thorough coverage is especially important in date-mite control.

SUMMARY

Progress is reported on the use of the following insecticides applied for the control of nitidulid beetles infesting dates: 1 per cent and 2.5 per cent dieldrin, 2 per cent lindane, 2 per cent parathion, 1 per cent parathion + 1 per cent dieldrin mixture, and 1 per cent lindane + 1 per cent dieldrin mixture. All of these compounds are toxic to the nitidulid beetles infesting dates, and all show promise of effective control in the field; the use of lindane is limited,

3. Sometimes abbreviated to DMC. Supplied under the trade name **Dimite** by the Sherwin-Williams Company.

Table 5. — Residual Data for Khadrawi Dates Dusted with 1 Per Cent Parathion Applied at the Rate of 40 to 60 Pounds Per Acre

Dust application, 1949	Parathion residue at harvest* (parts per million)
None (control)	0.00
July 27	0.04
Aug. 3	0.10
Aug. 10	0.07
Aug. 17	0.20
Aug. 25	0.06

*Fruit picked September 29, 1949.

Table 6.—Effectiveness of Various Acaricides Applied as Dusts on Date Bunches for Date-Mite Control, 1949

Acaricide	Days effective
4% p-chlorophenyl-p-chlorobenzenesulfonate*	0
4% beta-(p-tertiarybutylphenoxy)-beta'-chloroethyl-alpha'-methylethyl sulfite†	0
4% ethyl p-nitrophenyl thionobenzenephosphonate‡	0
4% 2, 4-dichlorophenylbenzenesulfonate§	0
4% 2-nitro-1, 1-bis(p-chlorophenyl)propane**	0
4% dinitrocapryl phenyl crotonate††	0
2% di-(p-chlorophenyl)methylcarbinol‡‡	0
4% di-(p-chlorophenyl)methylcarbinol‡‡	28
Experimental Kolo Dust (84% sulfur containing 13.5% bentonite sulfur)	21
Sulfur	43

* **K-6451**, The Dow Chemical Company.
† **Aramite**, Naugatuck Chemical Division, United States Rubber Company.
‡ **EPN-300**, E. I. duPont de Nemours & Company, Inc.
§ **Genitol 923**, General Chemical Division, Allied Chemical & Dye Corporation.
** **CS-645A**, Commercial Solvents Corporation.
†† **Karathane**, Rohm & Haas Company.
‡‡ **Dimite**, Sherwin-Williams Company.

however, as it imparts an off-flavor to certain varieties of dates. Dieldrin has shown longer residual toxicity than any other compound yet tested against these beetles, but it is still being tested for toxicity to warm-blooded animals.

The importance of timing of applications was well demonstrated in a series of experiments conducted in 1949. Dusts applied one and two weeks prior to the first picking gave no control, whereas the same dusts applied three weeks prior to the first picking gave moderate control, and the same dusts applied four weeks prior to the first picking gave very effective control.

Both parathion and dieldrin appear very promising in the control of these beetles. A method of analysis for parathion residue is available, but there is at present no method for analysis of dieldrin residues. Parathion residues at harvest were below the tentative target tolerance of 2 parts per million.

Further experimental work is necessary to properly evaluate these compounds in the field. It is anticipated that during the forthcoming season applications can be made which will be comparable to those made under commercial conditions.

Several new acaricides were tested against the date mite, but sulfur continues to be the most effective and cheapest method of control when properly applied.

LITERATURE CITED

(1) *Barnes, Dwight F., and D. L. Lindgren. 1946. The beetle infestation in dates. Date Growers' Inst. Ann. Rept. 23:34-35.*

(2) *Barnes, Dwight F., and D. L. Lindgren. 1947. Progress of work on beetle infestation in dates. Date Growers' Inst. Ann. Rept. 24:3-4.*

(3) *Lindgren, D. L., D. E. Bliss, and D. F. Barnes. 1948. Insect infestation and fungus spoilage of dates —Their relation and control. Date Growers' Inst. Ann. Rept. 25:12-17.*

(4) *Lindgren, D. L., and L. E. Vincent. 1949. Investigations on the life history and control of date insects and the date mite. Date Growers' Inst. Ann. Rept. 26:21-24.*

(5) *Lehman, A. J. 1949. Pharmacological considerations of insecticides. Assoc. Food & Drug Off. of the United States. 13(2):65-70.*

SECOND REPORT ON DATE-BUNCH COVERS AND THEIR RELATION TO THE FRUIT-SPOILAGE COMPLEX OF DEGLET NOOR DATES[1]

D. E. Bliss, D. L. Lindgren, W. D. Wilbur, and L. E. Vincent[2]

In 1949 the writers (3) discussed the advantages and disadvantages of different types of date-bunch covers in relation to the fruit-spoilage complex of Deglet Noor dates, and presented a progress report on field experiments of the crop year 1948-49. Certain experimental paper covers (brown A2 type) had been found to be outstanding in relative strength and durability, and low in cost, when compared with several other types of experimental covers and with the waxed paper cover (brown A1 type) then being used commercially on the Deglet Noor variety. The use of covers was found to be an important factor in controlling date-fruit spoilage, but the cover was not enough in itself to insure the maximum degree of control then possible. A combination of protective measures, including date covers, was recommended.

Additional comparative tests have been made to confirm the results of the preliminary work, and to provide information on the suitability of certain new materials for use in date-bunch covers. The present paper concerns field experiments of the crop year 1949-50, and is the second progress report on this subject.

MATERIALS AND METHODS

EXPERIMENTAL DATE-BUNCH COVERS. Four types of paper and two types of cloth were used in making the date-bunch covers for these experiments. The commercially used waxed brown paper cover (A1 type) was used as a basis for comparison. The other three paper covers included the brown A2 and the white C2 types, which had given outstand-

1. Paper No. 646, University of California Citrus Experiment Station, Riverside, California.

2. The writers again wish to express their appreciation to Donald H. Mitchell and H. L. Cavanagh, in whose orchards the experiments were conducted; and to the Longview Fibre Company, Longview, Washington, for making and testing the experimental paper covers. Appreciation is also expressed to McCampbell and Company, New York, N. Y., the Organic Chemicals Department of E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware, and the Great Western Division of The Dow Chemical Company, Seal Beach, California, for supplying experimental materials; and to Ellis F. Darley and Paul D. Gerhardt, for assistance.

ing results in previous experiments (3), and a new Manila B2 type designed to embody, as nearly as possible, the superior strength and durability of the brown A2 type and the light color of the white C2 type. Paper for the Manila B2 covers had also been made as porous as possible.

All four paper covers were produced from 55-pound, No. 1 Kraft paper, which, after receiving various types of processing, had been creped to 33 1/3 per cent stretch and made into tubes 36 by 44 inches. The paper for the brown A1 covers had had normal rosin size treatment and 8 pounds of dry wax (15 per cent of 55 pounds) absorbed into the sheet. (Most of the paper covers now being used commercially on the Deglet Noor variety have had this same processing.) In contrast, the papers for the brown A2, Manila B2, and white C2 covers had been given higher-than-normal rosin size treatment plus the Melamine wet-strength treatment for a moderate degree of wet strength, but no wax. These four papers differed from each other mostly in color: that for the white C2 covers was fully bleached (whitened), that for the brown A1 and A2 covers was unbleached (retaining the natural brown color of Kraft paper), and that for the Manila B2 covers was partially bleached to give a light shade of brown.

Some of the Manila B2 paper covers were altered by cutting six evenly spaced, V-shaped "breather" holes 8 inches below the upper edge of the tube to increase ventilation in the fruit bunch. These holes were 2 inches wide at the top and 4 inches long, and the flaps remained attached at the top.

All the cloth covers were made of a cotton muslin described technically as 36-inch, 32x28 Southern Brighton Tobacco Cloth. Although this cloth is said to have moderate water-repelling properties, some of the material was treated with 6 per cent "Zelan" AP paste to further increase water repellency. Bunch covers from both the untreated and the treated types of Tobacco Cloth were made in the form of tubes, but they were 16 inches longer than the paper covers (36x60 inches).

At the time of installation, all the covers were raised about the fruit bunches, gathered at the top in such a manner as to prevent the entrance of water, and tied securely to the fruitstalks above the strands. In treatment 9, however, the paper covers were gathered only at one side and tied to the fruitstalks, while the rest was folded over and left hanging free. This style of application, called the "flap fold," was used to increase the amount of aeration through the fruit bunch. When the cloth covers were installed, they were gathered and tied both above and below the fruit bunches to prevent the entrance of insects.

Experimental Plots. The experimental plots were located in the same two commercial date orchards in which the 1948 experiments were conducted (3). Plot I was in an orchard 2 miles south of Indio, California, and Plot II, in an orchard in the Indian Wells district, 5 miles west of Indio. These plots consisted of 17 and 16 medium-sized Deglet Noor palms, respectively, situated well in from the edge of the planting. Plot I was interplanted with citrus trees which stood about 10 to 12 feet high; Plot II was without any interplanted crop. Well-pollinated, uninjured fruit bunches of midseason development were selected for the experiment, usually at the rate of five per palm.

Treatment of Fruit Bunches. Twelve types of treatment, including three control treatments and nine experimental treatments, were assigned to the selected bunches in an orderly but impartial arrangement. Except for sulfur, which had been applied uniformly to all fruit bunches in June as a protection against the date mite, *Paratetranychus simplex* (Banks), the bunches of Control A (treatment 1) were left without further treatment. Beginning on July 19, the bunches of Control B (treatment 2) were aerated by means of 9-inch corrugated wire rings and dusted with Thiomate "19" (2), but they were not protected by any cover. The bunches of Control C (treatment 3) were left untreated, like those of Control A, except that, beginning August 24, they were protected with brown A2 paper covers. This type of control, which had not been employed in the previous experiments, was intended to demonstrate the development of fruit spoilage in bunches protected by paper covers but without wire rings to provide aeration and without Thiomate "19" to give fungicidal protection. All the remaining bunches (experimental treatments 4 to 12, inclusive) were aerated by means of wire rings, and all were dusted with Thiomate "19," except those of treatment 10, which received 5 per cent dehydroacetic acid in sulfur. These fungicides were applied on July 19 and August 24, and on the latter date the various types of fruit-bunch covers were also applied. On September 13 wire baskets were suspended under the fruit bunches of treatments 1 to 10, inclusive, to catch falling dates.

Picking and Grading Operations. Ripened dates were picked from the experimental bunches at 2- to 4-week intervals, using a method similar to that of previous experiments (3, 4). Six pickings were made in both plots from October 4, 1949, to January 10, 1950. Each reading of insect infestation was made from a 50-fruit sample collected at random from a fruit bunch at the beginning of a picking and securely tied in a new paper sack to prevent the escape of insects. Each reading of fruit quality, tearing from water injury, fungus spoilage, and bird injury, was made from a 100-fruit sample taken at random from the remaining dates.

ENVIRONMENTAL FACTORS

Freezing temperatures in January, 1949, caused considerable injury to the foliage of date palms in the Coachella Valley. This injury resulted in the loss of approximately one third of the green leaf area of palms in the experimental orchards. The growers, wishing to avoid the ill effects of alternate bearing (5), reduced the fruit load proportionately. Both the number and the size of the fruit bunches were reduced in Plot I, whereas in Plot II only the number of bunches was reduced.

Rainfall recorded at Indio and Palm Springs, California, during the period July, 1949, to January, 1950, inclusive (table 1), was less than that of any similar period since 1942. A localized storm, with an estimated precipitation of 0.5 inch, occurred at Plot II on August 22, shortly before the bunch covers were installed. This storm, the first of the season, probably contributed materially to the water injury which was later observed in the fruit from that plot. The other rainstorms were so slight and widely spaced that only minor injury resulted.

Table 1.—Rainfall Recorded at Indio and Palm Springs, California, July, 1949, to January, 1950, Inclusive*

Date		Rainfall, in inches	
		Indio	Palm Springs
1949:			
July	1-31	.....	.....
Aug.	22	.....	0.03
	23	0.02	.....
Sept.	1-30	.....	.....
Oct.	17	.....	0.10
	19	0.08	.....
Nov.	11	0.13	.....
Dec.	8	0.01	.....
	9	0.18	0.20
	18	.....	0.13
	19	.....	0.05
	20	.....	Trace
1950:			
Jan.	9	0.03	.....
	12	0.01	.....
	29	Trace	.....

*Climatological Data, California Section, U. S. Weather Bureau, Vol. 53, 1949, and Vol. 54, 1950.

RESULTS

FRUIT INJURY CAUSED BY SUNBURNING OF FRUITSTALKS AND FRUITSTRANDS. In November, 1949, after the covers had been in place for three months, the experimental fruit bunches together with their fruitstalks and fruitstrands were examined for symptoms of sunburning. Slight to moderate burning had occurred on 8 out of 10 bunches covered with the brown A1 paper covers, whereas only 3 of the 101 remaining bunches were affected. Two bunches under Manila B2 paper covers showed slight injury, and one uncovered bunch was moderately affected. These injuries, although less marked than those recorded for the previous year (3), served to emphasize again an unsatisfactory feature of the brown A1 type of bunch cover.

FRUIT QUALITY. As indicated by the weighted-mean ratings of the fruit samples from the different treatments, fruit quality was improved in all treatments by using a combination of wire rings for ventilation, Thiomate "19," and bunch covers (table 2).

Treatment 9 (Manila B2 paper tube with flap fold) yielded fruit of highest quality in Plot I, while the dates from treatment 4 (brown A1 paper tube) were rated the best in Plot II. The quality of fruit from treatments which differed only in the type of bunch cover, however, was generally quite uniform.

WATER INJURY AND BLACKNOSE. The quality of fruit, especially that in Plot II, was reduced in 1949 because of severe checking and blacknose. Checking was already well advanced before the installation of bunch covers, and the use of wire rings did not noticeably affect its intensity. Tearing, a more severe type of water injury, was of minor importance because only a little free moisture touched the fruit during the khalal and rutab stages of maturity. A mild form of tearing was found most commonly in bunches which had not been provided with wire rings (table 2). A general tendency toward fruit shrivel reflected the dry, desiccating environment during most of the ripening season.

FUNGUS SPOILAGE. The incidence of fungus spoilage, like that of tearing, was at a relatively low level in 1949 (table 2). Whereas in Plots I and II the untreated fruit of Control A had only 2.4 and 4.7 per cent rot, respectively, the fruit of Control B (wire rings and Thiomate "19") had 1.4 and 0.9 per cent, and that from Control C (brown A2 paper tubes) had 15.3 and 5.5 per cent. Under these peculiar conditions, the use of wire rings and Thiomate "19" reduced fungus spoilage, while the use of bunch covers increased it. In treatment 5, which was like Control C except for the use of wire rings and Thiomate "19," fungus spoilage was only 2.7 and 2.0 per cent in Plots I and II, respectively. The detrimental effect of the covers had apparently been counterbalanced by the beneficial effects of the rings and fungicide. Results from the remaining treatments were similar to those of treatment 5. This applied to the regular paper tubes, regardless of color, to the covers with "breather" holes and flap folds, and also to the Tobacco Cloth covers with and without Zelan treatment. In these tests the fungicidal effect of 5 per cent dehydroacetic acid in sulfur (treatment 10) was apparently comparable to that of Thiomate "19."

As in former years (1, 2, 3, 4), the microorganisms associated with fungus spoilage included species of *Aspergillus, Alternaria, Pleospora, Penicillium, Hormodendrum, Diplodia,* and *Rhizopus.*

INSECT INFESTATION. The infestation by pyralid moths[3] was less in 1949 than in any of the three previous years. No significance can be attached to any of the treatments (table 2).

The infestation of dates by nitidulid beetles[4] confirmed previous observations that a positive correlation exists between the amount of fungus spoilage and of insect infestation (3, 4). In control C, in which the highest percentages of fungus

3. The raisin moth, **Ephestia figulilella** Greg., and the Indian-meal moth, **Plodia interpunctella** (Hbn.), both of the order Lepidoptera, family Pyralidae.

4. **Carpophilus hemipterus** (L.), **C. dimidiatus** (Fab.), **Urophorus humeralis** (Fab.), and **Haptoncus luteolus** (Er.), all of the order Coleoptera, family Nitidulidae.

Table 2.—Effect of Various Treatments on Fruit Quality, Tearing Caused by Water Injury, Fungus Spoilage, Insect Infestation, and Bird Injury of Deglet Noor Dates in Plots Near Indio, California, 1949

Treatment No.*	Type of fruit-bunch cover	Total amount of fruit (kg.)		Fruit-quality rating (10=perfect)		Tearing from water injury (per cent)		Fungus spoilage (per cent)		Infestation by: Pyralid moths (per cent)		Infestation by: Nitidulid beetles (per cent)		Bird injury† (per cent)	
		Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II
1	None (Control A)	53.0	50.6	5.9	4.6	2.3	8.1	2.4‡	4.7	0.9	0.0	1.70	0.30	13.3	12.8
2	None (Control B)	44.4	54.3	5.4	5.0	4.2	2.6	1.4‡	0.9‡	0.2	0.0	1.90	0.08	9.7	22.0
3	Brown A2 paper tube (Control C)	43.7	56.0	4.9	5.4	5.2	3.2	15.3	5.5	0.5	0.9	4.40	2.20	0.2	1.2
4	Brown A1 paper tube	41.4	50.3	6.7	6.2	1.2‡	2.3	2.1‡	1.0‡	0.0	0.0	0.10‡	0.00	0.4	3.0
5	Brown A2 paper tube	40.9	57.1	6.2	5.8	1.9	2.4	2.7‡	2.0‡	0.3	0.1	0.90	0.20	0.6	1.0
6	Manila B2 paper tube	44.4	64.9	6.5	5.8	2.9	0.9	3.2‡	2.1	0.1	0.0	1.50	0.00	0.6	2.4
7	White C2 paper tube	38.2	59.4	6.8	5.7	1.1	3.7	2.2‡	3.5	0.1	0.1	0.60	0.10	0.2	0.2
8	Manila B2-B paper tube (with "breather" holes)	37.5	58.3	6.4	5.6	2.1	3.9	2.3‡	2.2	0.5	0.3	0.40	0.10	0.0	0.6
9	Manila B2 paper tube (with flap fold)	47.0	56.5	7.2	5.7	1.5	2.6	2.4‡	1.5‡	0.2	0.0	0.30‡	0.00	0.2	0.6
10	Manila B2 paper tube	34.9	53.8	6.9	5.8	1.5	1.7	0.9‡	2.3	0.0	0.0	0.00‡	0.00	0.2	3.0
11	Tobacco Cloth tube (closed)	45.7	44.6	6.5	5.5	2.5	3.8	1.2‡	0.6‡	0.2	0.0	0.09‡	0.10	0.0	0.0
12	Zelan-treated Tobacco Cloth tube (closed)	7.4	.....	6.0	....	1.7	....	0.9	....	0.0	....	0.00	.....	0.0	....

*All treatments except Nos. 1 and 3 included fruitstrand separation by wire rings, and all except Nos. 1, 3, and 10 included fungicidal dust treatment with Thiomate "19." No. 10 received 5 per cent dehydroacetic acid in sulfur as a fungicidal dust treatment.

†Based on Fruit picking of November 29, 1949.

‡Difference, in comparison with Control C, significant at the 5 per cent level, as shown by the "t" test (6).

spoilage occurred in both Plots I and II, the infestation of fruit by nitidulid beetles was also the greatest (table 2). In the other treatments, where the percentages of fungus spoilage were low, a corresponding reduction in insect infestation was also evident. Although infestation by nitidulid beetles was significant at the 5 per cent level in four treatments in Plot I, no definite conclusions can be drawn regarding the relative merits of the treatments. No significant differences were shown in Plot II.

Bird Injury. Mechanical injury resulting from the feeding of birds on ripening dates was moderately severe, especially in the uncovered fruit bunches of Controls A and B (table 2). Data based on the fruit picking of November 29 indicated that, in Plot I, injury to uncovered fruit was 9.7 to 13.3 per cent; to fruit under paper bunch covers, 0.2 to 0.6 per cent; and to fruit enclosed in cloth covers, none. In Plot II, injury to uncovered fruit was 12.8 to 22.0 per cent; to to paper-covered fruit, 0.6 to 3.0 per cent; and to fruit in cloth tubes, none. Bird injury tended to increase as the season progressed.

Physical Properties of Paper Date-Bunch Covers. Unused and used experimental paper covers of all types were returned to the manufacturer for testing at the end of the fruit harvest. The unused covers had been stored at Riverside while the used covers were being exposed to the weather and to fruit-picking operations in the experimental plots for a period of 139 days, beginning August 24, 1949. Three standard tests, the same as those reported previously (3), were applied to dry and wet samples of all types to obtain further information on the bursting strength (Mullen), the tensile breaking strength, and the internal tearing resistance of these papers. The results of these tests were thought to be indicative of the strength and relative durability of the paper covers in the orchard.

Tests on the unused paper covers showed that the brown A2, Manila B2, and white C2 papers which had received higher-than-normal rosin size plus the Melamine wet-strength treatment were, in general, stronger than the commercially used brown A1 paper which had been treated with normal rosin size and contained 15 per cent wax (table 3). Unused Manila B2 covers, both dry and wet, demonstrated the greatest bursting strength (Mullen) and internal tearing resistance, but were comparatively weak in tensile breaking strength. The unused white C2 covers showed greater strength than in the previous tests (3), and were outstanding in tensile breaking strength. They, however, exhibited least tearing resistance in machine direction. The unused brown A2 covers were uniformly second to the strongest in all tests.

Tests on the used paper covers after exposure to weather and fruit-picking operations for 139 days indicated that, in general, the strength of the paper had decreased with use (tables 3 and 4). Here again the so-called wet-strength papers were stronger than the waxed paper. On the average, outstanding results in bursting strength (Mullen) and in internal tearing resistance were obtained from the used Manila B2 covers. These covers, when wet, were inferior to the others, however, in tensile breaking strength. In contrast to this, the values for the used brown A2 covers were comparatively high in all tests, ranking first or second in seven of the eight catagories.

A tentative index of durability (3) was obtained by averaging the percentages of retained strength and internal tearing resistance (table 4). The highest index rating (84.9) was that of brown A2 paper covers from Plot II; the lowest index rating (73.0) was that of Manila B2 paper covers from Plot II. The average index ratings for the four kinds of paper, in descending order, were brown A2, white C2, brown A1, and Manila B2. From both plots the Manila B2 covers with "breather" holes rated considerably above similar covers without holes.

The relative condition of the date-bunch covers as observed in the orchard three months after installation indicated that the Manila B2 covers were not holding up as well as the brown A2 covers. All covers were examined again at the close of the season, after being removed from the palms, to determine the number of each kind remaining in a usable condition. Only 60 to 80 per cent of the Manila B2 covers (with and without "breather" holes) were still in a usable condition, whereas all the

Table 3.—Relative Strength and Internal Tearing Resistance of Unused and Used Paper Tubes from the Date Fruit-Spoilage Experiments, 1949*

Treatment No.	Paper fruit-bunch cover		Bursting strength (Mullen) (lbs. per sq. in.)		Tensile breaking strength, machine direction (lbs. per in. width)		Internal tearing resistance (per cent of basis weight)			
							Machine direction		Cross machine dir	
	Type	Condition and source†	Dry	Wet‡	Dry	Wet§	Dry	Wet§	Dry	Wet§
4	Brown A1	Unused	22.6	16.8	27.8	8.0	222	222	222	206
		Used (Plot I)	20.8	14.7	23.4	6.4	154	182	172	164
		Used (Plot II)	18.4	13.6	19.2	6.3	160	178	160	160
3 and 5	Brown A2	Unused	30.0	23.3	30.2	8.3	230	231	272	231
		Used (Plot I)	23.5	18.2	24.2	6.6	210	198	210	210
		Used (Plot II)	22.5	17.7	31.2	6.9	227	196	227	196
6, 8, 9, and 10	Manila B2	Unused	38.6	28.7	28.4	7.3	287	298	287	250
		Used (Plot I)††	30.5	19.8	21.2	4.6	181	264	252	205
		Used (Plot I)	33.8	22.0	20.3	4.6	196	248	222	287
		Used (Plot II)††	33.0	19.6	22.0	4.4	175	244	200	200
		Used (Plot II)	34.7	21.4	22.1	5.2	223	248	212	236
7	White C2	Unused	29.4	22.7	36.2	9.8	198	198	232	209
		Used (Plot I)	23.7	19.3	26.0	6.5	184	184	206	206
		Used (Plot II)	21.0	17.3	30.1	7.2	165	165	187	165

* Data supplied by R. S. Wertheimer, Resident Manager, Longview Fibre Company, Longview, Washington.

† Used covers were exposed to weather and fruit-picking operations for a period of 139 days, beginning August 24, 1949.

‡ Samples soaked in water 10 minutes at 70° F.

§ Samples soaked in water 60 minutes at 70° F.

††Covers supplied with "breather" holes.

Table 4.—Percentage of Retained Strength and Internal Tearing Resistance of Paper Tubes After Use as Date-Bunch Covers for a Period of 139 Days*

Test	Condition of paper	Type of cover and source									
		Brown A1		Brown A2		Manila B2		Manila B2-B†		White C2	
		Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II	Plot I	Plot II
Bursting strength (Mullen)	Dry	92.2	81.4	78.3	75.0	79.0	85.4	87.6	89.8	80.6	71.4
	Wet‡	87.5	80.9	78.2	75.8	69.0	68.2	76.5	74.5	85.0	76.2
Tensile breaking strength, machine direction	Dry	84.2	69.0	80.2	103.2	74.7	77.4	71.3	77.8	71.8	83.2
	Wet§	80.0	78.8	79.4	83.1	63.0	60.3	63.0	71.2	66.3	73.6
Internal tearing resistance, machine direction	Dry	69.5	72.2	91.3	89.5	63.0	61.0	68.2	77.7	92.9	83.2
	Wet§	82.0	80.3	85.6	84.8	88.8	82.0	83.3	83.3	85.0	83.2
Internal tearing resistance, cross machine direction	Dry	77.5	72.2	77.2	83.4	87.8	69.6	77.6	73.8	88.8	80.6
	Wet§	79.6	77.7	90.8	84.8	82.0	80.0	114.8	94.4	98.5	78.9
Tentative index of durability (average)		81.5	76.6	82.6	84.9	75.9	73.0	80.2	80.3	83.6	78.8

*Data supplied by R. S. Wertheimer, Resident Manager, Longview Fibre Company, Longview, Washington.
†Covers supplied with "breather" holes.
‡Samples soaked in water 10 minutes at 70° F.
§Samples soaked in water 60 minutes at 70° F.

others were usable (table 5).

DISCUSSION

Rainfall during the fruit-ripening season has long been considered one of the most important environmental factors in the development of date-fruit spoilage. In the virtual absence of rainfall during the latter part of 1949, however, fungus spoilage of dates was increased by the use of paper covers on otherwise untreated bunches (Control C). Presumably because of the transpired moisture trapped by the covers, environmental conditions in the covered, nonventilated fruit bunches were more conducive to fungus spoilage than those in the noncovered, nonventilated bunches (Control A). In Plot I this difference in spoilage was significant (table 2). The use of wire ventilating rings and Thiomate "19" had the usual effect of controlling fungus spoilage, but spoilage in most of the covered, aerated and dusted bunches was higher than that in the noncovered, similarly treated bunches (Control B). Two conflicting factors were at work in the former: first, high moisture (caused by the covers) promoting disease development; and second, low moisture (as a result of ventilating rings) and fungicide preventing it.

A direct correlation between fungus spoilage and infestation of dates by the nitidulid beetles was again demonstrated by these experiments. The beetles, being scavengers, are attracted to various kinds of plant materials undergoing fungus and bacterial decomposition. Insect infestation of dates is therefore affected indirectly by any conditions influencing the amount of fungus spoilage.

In comparing the relative merits of date-bunch covers, two important factors should be considered: (a) the effect on the fruit (quality, water injury, fungus spoilage, infestation by insects, bird injury, etc.), and (b) economy of use (initial cost, cost of installation, durability, etc.). In 1949 the use of date-bunch covers was without benefit except as a protection against birds. In years of greater rainfall bunch covers also protect the fruit from fungus infection, infestation by insects, and tearing due to water injury, but they tend to increase injury from checking and sunburning.

Our experiments with Tobacco Cloth covers were not sufficiently extensive or critical to warrant an opinion. There were indications of superiority over the paper tubes in the prevention of sunburning, insect infestation, and bird injury, but the question of rain protection was not answered.

Confirmation of previous tests (3) was obtained regarding the general superiority of the new wet-strength paper covers over the waxed brown paper covers now being used most commonly on the Deglet Noor variety. The Manila B2 cover had been developed especially for these experiments with the intention of combining, as far as possible, the best features of the brown A2 and the white C2 covers. A light-brown paper of high bursting strength and internal tearing resistance was achieved, but it was later found to be relatively low in tensile breaking strength and in durability. It may be that the manufacturer, in attempting to increase the porosity of the Manila B2 paper, unintentionally sacrificed some of its strength and durability.

The development of a durable B2-like cover seems highly desirable,

Table 5.—Relative Usability of Paper Date-Bunch Covers After One Season's Service

Type	Date-bunch covers					
	Plot I			Plot II		
	Total used	Remaining usable		Total used	Remaining usable	
		Number	Per cent		Number	Per cent
Brown A1	5	5	100	5	5	100
Brown A2	11	11	100	11	11	100
Manila B2	15	11	73	15	11	73
Manila B2-B*	5	3	60	5	4	80
White C2	5	5	100	5	5	100

*Covers supplied with "breather" holes.

and we hope that such a cover may yet be forthcoming. In the meantime, the brown A2 cover appears to be better suited for commercial use on the Deglet Noor variety than any of the other covers tested. This unbleached Kraft paper is processed with higher-than-normal rosin size plus the Melamine wet-strength treatment and creped to 33 1/3 per cent stretch, but contains no wax. In the orchard this cover was satisfactory in all respects except for sunburning of fruit (3), and in this it was probably somewhat better than the present A1 cover. The brown A2 paper was less pliable than the brown A1 paper, but this was not considered to be a serious fault. Further work is needed to test the desirability of using "breather" holes or flap folds in the bunch covers to increase ventilation of the fruit.

As previously stressed (3), the most effective control of date-fruit spoilage in the Deglet Noor variety may be obtained through the use of various improved cultural practices, and of a combination of disease and pest-control measures, such as: (a) wire rings for fruit-bunch aeration, (b) Thiomate "19" against fungus infection, (c) improved paper covers against fruit tearing and bird injury, (d) sulfur dust against date mites, and (e) orchard sanitation against nitidulid beetles. The use of improved paper covers, although important, is not enough in itself to insure the maximum degree of control now possible under practical conditions.

SUMMARY

A second progress report is made on experiments with different types of date-bunch covers for the control of fruit spoilage of the Deglet Noor date in two field plots in the Coachella Valley of California. Three control and nine experimental treatments were employed.

The date-bunch covers were made either of paper or of cloth. The paper used (No. 1 Kraft, unbleached, semibleached, and bleached) was processed in two ways, and the paper covers were designated, accordingly, as brown A1 and A2, Manila B2, and white C2. Certain Manila B2 covers were made with "breather" holes, and others were installed with a flap fold to increase aeration of the fruit. Tobacco Cloth was used for all cloth covers, but some of the cloth was treated with Zelan paste to increase water repellency. All covers were made in the form of tubes. The cloth covers were longer than the paper covers and were closed at the bottom.

Slight to moderate sunburning occurred on 8 out of 10 bunches covered with the commercially used waxed brown A1 paper covers, whereas only 3 of the 101 remaining bunches were affected.

The virtual absence of rain at the experimental plots during the latter part of 1949 resulted in a low incidence of tearing due to water injury. Checking and blacknose, however, were relatively severe. Fruit quality was improved in all treatments by using a combination of wire ventilating rings, Thiomate "19," and bunch covers. Fungus spoilage was decreased by the use of wire rings and Thiomate "19," but was increased by the use of paper covers alone.

No significance was attached to any of the treatments in controlling insect infestation, except that a positive correlation was again found between the incidence of fungus spoilage and infestation by the nitidulid beetles.

Mechanical injury resulting from the feeding of birds on ripening dates ranged from 9.7 to 22 per cent in uncovered bunches and from 0.2 to 3 per cent in paper-covered bunches; under cloth covers there was no injury.

Tests on the paper covers showed that the brown A2, Manila B2, and white C2 papers which had received higher-than-normal rosin size plus the Melamine wet-strength treatment were, in general, stronger than the commercially used brown A1 paper which had been treated with normal rosin size and contained 15 per cent wax. The Manila B2 cover, which had been developed especially to embody, so far as possible, the strength and durability of the brown A1 cover and the light color of the white C2 cover, was outstanding in all tests except that of tensile breaking strength, but was relatively poor in durability.

The brown A2 cover appears to be better suited for commercial use on the Deglet Noor variety than any of the other covers tested. No conclusions were drawn from the use of Tobacco Cloth covers. A combination of disease and pest-control measures, including the use of improved bunch covers is recommended.

LITERATURE CITED

1. *Bliss, Donald E., 1946. The use of fungicides against spoilage in dates. Date Growers' Inst. Ann. Rept. 23:13-17.*
2. *Bliss, Donald E., and David L. Lindgren. 1947. The use of Thiomate "19" on dates, and its effect on fruit spoilage. Date Growers' Inst. Ann. Rept. 24:5-9.*
3. *Bliss, D. E., D. L. Lindgren, W. D. Wilbur, and L. E. Vincent. 1949. Date-bunch covers and their relation to the fruit-spoilage complex of Deglet Noor dates. Date Growers' Inst. Ann. Rept. 26:7-15.*
4. *Lindgren, D. L., D. E. Bliss, and D. F. Barnes. 1948. Insect infestation and fungus spoilage of dates—their relation and control. Date Growers' Inst. Ann. Rept. 25:12-17.*
5. *Mathez, Forrest, and Donald E. Bliss. 1942. The relation of leaf area to alternate bearing in the Deglet Noor palm. Date Growers' Inst. Ann. Rept. 19:3-7.*
6. *Snedecor, George W. 1946. Statistical methods. 4th ed. 485p. Collegiate Press, Inc., Ames, Iowa.*

PROGRESS REPORT: THE EFFECT OF FOUR INSECTICIDES UPON THE CONTROL OF BEETLE INFESTATION IN SOIL AND DROPPED DATES

R. H. Hilgeman and G. C. Sharples
University of Arizona Citrus Experiment Station, Tempe, Arizona

Because of renewed interest in date production in Arizona in recent years, the date research program of the University of Arizona Agricultural Experiment Station was reactivated during the past year. Research is directed toward the reduction of date spoilage, the most serious problem in Arizona, by (1) regulation of irrigation; (2) packing house sanitation, and fumigation; (3) reduction of insect population. This paper presents preliminary data upon the efficiency of four insecticides in killing dried fruit beetles.

Since most of the dates grown in Arizona are soft dates, organic insecticides applied to the fruit on the palm are unsatisfactory because of the difficulty of removing the residues. Although repeated observations and experiments (1, 3 and 4) have emphasized the value of garden sanitation as a means of reducing insect population, many growers find it impractical to remove fallen dates. The dried fruit beetle (*Carpophilus Hemipterus* L.) and the corn sap beetle (*Carpophilus Dimidiatus* F.) which cause the major part of the damage, pass through part of their life cycles in the soil (2). Therefore, it was considered logical to investigate their control by means of applications of insecticides applied to dates on the soil surface. Such a program, which has been recommended by Lindgren, et al (4), would appear to be an easy way to reduce insect populations, if control could be accomplished by spraying the dropped fruit and soil once or twice during the season.

METHODS AND MATERIALS

Two experiments were conducted at the University of Arizona Citrus Experiment Station near Tempe, Arizona, during the summer and fall of 1949. In each experiment a palm leaf shaded plot 25x25 feet in size was covered with a layer of dates and irrigated. After about 10 days, when the insect population was high, 25 sub plots were laid out and five treatments were applied according to a latin square design. Each plot was sprayed or dusted with a hand sprayer or duster. The effectiveness of the treatments was determined from daily counts of the adults which emerged from each treatment. This was accomplished by the use of emergence cages 28"x36" in size with a small hole in the upper side where the adult insects entered a glass fruit jar.

Experiment I. Effectiveness of Four Organic Insecticides. This experiment, conducted between June 7-27, evaluated equal concentrations of four insecticides (Table I).

The emergence of the beetles was extremely variable so that error values were high and large differences between means were required for significance. The emergence of beetles the first day after treatment, which represents the initial effectiveness of the materials in killing adults, show that parathion, chlordane and toxaphene significantly reduced populations (Table 2).

Emergence between the 2nd to 12th day inclusive reflects the effectiveness of the materials in killing larvae and emerging adults. Parathion and chlordane produced a highly significant reduction over the control, toxaphene a significant reduction and benzene hexachloride was ineffective.

After the first day, each morning when the insects were counted the number which appeared to be dead or dying in the traps was estimated. About 80 per cent of the beetles which were trapped in the parathion treated plots were dead, lesser numbers of dead insects were found in the remaining treatments. Since the insects died soon after reaching the trap it appears that parathion was actually more effective than was indicated by the actual count.

A relationship between emergence rate and surface soil temperatures under the cages occurred. During the first 11 days the mean soil temperatures increase from 82° to 89° and the rate of emergence of insects increased. After the 12th day a sharp drop in mean temperature back to 82° caused emergence of beetles to decrease. The maximum soil temperature on the warmest days was 100°.

Experiment II. Period of Effectiveness of Parathion. Experiment 1 indicated that soil applications of parathion dust were highly effective in killing larvae and adults. However, its period of effectiveness was not established. To establish this point plots prepared in a new area were sprayed with 50 lbs. of 15% wettable parathion per 100 gallons of water at the rate of 200 gallons per acre on Sept. 26. Emergence cages were placed on the plots (1) immediately after spraying, (2) 3 days after, (3) 9 days after, and (4) 20 days after. Because of cool weather the fifth set of cages were not placed. Soil surface temperatures dropped from a mean 83° to 52° during the 26 day duration of the experiment.

The emergence of the insects from the plots where cages were placed immediately after application of the insecticide was similar to that which occurred in Experiment I. However, the emergence from plots where cages were placed on the 3rd and 9th days was so high that it is clearly evident the material was ineffective for these periods (Figure 1).

Table 1.—Experiment I. Materials and Concentration Rates

Material	Concentration	Rate of Application
Parathion	2% dust	40 lbs. per Acre
Chlordane 40%	2 lbs. per 100 gal.	200 gal/Acre
Toxaphene 80%	1 lb. per 100 gal.	200 gal/Acre
Benzene Hexachloride 19.5% gamma isomer	4 lbs. per 100 gal.	200 gal/Acre
Control	No treatment	

Table 2.—Effect of Four Insecticides upon the Emergence of Adult Beetles

Material	Average Number of Insects Emerging			Estimated % Dead in Traps
	1st Day	2-12 Days	Total	
Parathion	195	8	203	80
Chlordane	177	69	246	30
Toxaphene	186	176	362	20
Benzene Hex.	345	364	709	15
Control	390	594	984	1
L. S. D. 5%	174	316	386	
L. S. D. 1%	240	435	532	

SUMMARY

The emergence of adult dried fruit and corn sap beetles (*Carpophilus spp*) from sprayed soil and fallen dates reveals that parathion, chlordane and toxaphene significantly reduced insect populations, and that benzene hexachloride was ineffective. Parathion which produced the most effective immediate control was ineffective within 3 days after applying it. The period of effectiveness for chlordane and toxaphene was not determined.

LITERATURE CITED

(1) Albert, D. W. and R. H. Hilgeman. Date Growing in Arizona. *University of Arizona Agr. Exp. Sta. Bull. 149, 1935.*

(2) Barnes, D. F. and D. L. Lindgren. Progress Report on Beetle Infestation in Dates. *Date Growers' Ann. Rept. 23:34-35. 1946.*

(3) Nixon, R. W., Date Culture in the United States, *U. S. Dept. of Ag. Cir. 728, 1945.*

(4) Lindgren, D. L., D. E. Bliss, and D. F. Barnes. Insect Infestation and Fungus Spoilage of Dates—Their Relation and Control. *Date Growers Institute Ann. Rept. 25:12-17, 1948.*

PROGRESS REPORT: EFFECTS OF HORMONE SPRAY APPLICATIONS UPON THE DEVELOPMENT AND RIPENING OF DATE FRUIT

George C. Sharples and R. H. Hilgeman
University of Arizona Citrus Experiment Station, Tempe, Arizona

The unequal ripening of date fruits and their susceptibility to rain damage increase production costs and make date growing an uncertain enterprise. Growth regulating chemicals or synthetic "plant hormones" offer possible aids in the solution of these problems. Such sprays have induced earlier maturity in Barlett pears (1), and McIntosh apples (2), more rapid growth and earlier maturity in tomatoes (5), and more even ripening of Redhaven peaches (4). Parthenocarpic fruit development accompanied by advanced maturity has been induced in the Calimyrna fig (3).

The results presented here are the first of a series of experiments to be conducted to determine the responses which may be expected through the application of synthetic hormones to the fruit or leaves of the date palm.

METHODS AND MATERIALS

Seven Sayer palms were selected at the University of Arizona Date Garden near Tempe. The late season delayed the opening of the spadices so that pollination occurred between April 25 and May 25, 1949. Soon after pollination six bunches on each palm were thinned to 45 strands. These strands were divided into 5 equal groups for subsequent treatments. One group was left as a control, the remaining groups were sprayed with water solutions of the following materials:

1. Na salt of 2, 4-dichlorophenoxy acetic acid.
2. a-naphthalene acetic acid.
3. a-(ortho chlorophenoxy) propionic acid.
4. Indole butyric acid.

Each material was applied to a group of strands on one bunch on each palm at the rate of 20 ppm. and similarly to a second bunch at the rate of 500 ppm. Sprays were applied on three dates representing different stages of fruit development: 1. May 13, soon after pollination; 2. June 15, just prior to the period of rapid enlargement; 3. Aug. 5, after fruit enlargement was nearly completed but prior to the development of the yellow khalal color.

A picking was made on Oct. 5, when the bunches were between 30 and 50 per cent ripe. The total number of fruit in each treatment and the number which were ripe or were beginning to ripen was recorded.

RESULTS AND DISCUSSION

The fruit in all treatments appeared to develop and ripen normally. No differences in fruit size or in the amount of dropped fruit were observed. In some treatments the number of replications was seriously reduced because of damage to bunches from "cross-cut" disease. Owing to this reduction in replications a statistical analysis of the data was not made. However, variation in ripening between replications was rather large.

While the differences in the percentage of fruit ripe on Oct. 5 are rather large, it appeared that these differences were due to time of pollination rather than due to treatments (Table I). By plotting pollination dates against percentage of ripe fruit for individual bunches, it was shown that a difference of 10 days in pollination date can easily account for a 5-10% variation in the number of ripe fruit on a given picking date.

It is reasonably concluded that the chemicals and concentrations used in this experiment had no stimulatory effect on the growth and ripening of normally pollinated dates of the Sayer variety.

LITERATURE CITED

1. *Allen, F. W. and A. E. Davey. Hormone sprays and their effect upon the keeping quality of Bartlett pears. Calif. Agr. Expt. Sta. Bul. 692. 1945.*
2. *Batjer, L. P. and A. H. Thompson. The transmission effect of naphthalene acetic acid on apple drop as determined by localized applications. Proc. Amer. Soc. Hort. Sci. 51:77-80. 1948.*
3. *Crane, J. C. and R. Blondeau. Controlled growth of fig fruits by synthetic hormone application. Proc. Amer. Soc. Hort. Sci. 54: 102-108. 1949.*
4. *Marth, P. C., C. P. Harley and A. L. Havis. Effect of 2, 4, 5-trichlorophenoxyacetic acid on the ripening of apples and peaches. Science III:331-332. 1950.*
5. *Mitchell, J. W. and P. C. Marth. Growth regulators for Garden, Field and Orchard. Univ. of Chicago Press. Chicago, Ill. 1947.*

Table I—Effect of Hormones Upon Ripening of Sayer Dates

Date Sprayed	Conc. ppm	Ave. Pollination Date	No. reps	Ave. % ripe, Oct. 5, 1949				
				2, 4-D[1]	ANA[2]	CPA[3]	IBA[4]	Cont.
5-13-49	20	5-1-49	4	47	56	48	45	42
	500	5-1-49	2	44	47	35	46	46
6-15-49	20	5-11-49	5	45	36	40	35	33
	500	5-11-49	5	34	30	33	43	31
8-5-49	20	5-9-49	6	38	34	33	36	31
	500	5-9-49	6	38	37	37	40	38

1. 2, 4-D—2, 4-Dichlorophenoxy acetic acid.
2. ANA—a-naphthalene acetic acid.
3. CPA—a-(ortho-chlorophenoxy) propionic acid.
4. IBA—Indole butyric acid.

DATE CULTURE IN FRENCH NORTH AFRICA AND SPAIN

Roy W. Nixon[1]
U. S. Date Garden, Indio, California

A fellowship granted by the John Simon Guggenheim Memorial Foundation and the cooperation of the U. S. Department of Agriculture recently made it possible for me to study date varieties and culture in relation to environment in French North Africa and Spain. I was in Algeria from August 25, 1948, to March 15, 1949, with the exception of the month before Christmas when I made a trip across the desert through the date country of southern Tunisia to Gabes on the Mediterranean coast. After leaving Algeria I spent three weeks in Morocco and two weeks in Spain before returning to the United States.

At Algiers, the capital of Algeria, where I first landed in North Africa, I had the pleasure of meeting again Monsieur J. Brichet, who in 1932 visited the U. S. Date Garden as a member of an agricultural mission from Algeria. Monsieur Brichet, formerly in charge of horticultural work in Algeria but now a retired horticultural consultant, had been apprised of my coming and had already paved the way for friendly contacts with the Office of the Southern Territories, which covers the areas where dates are grown. I am pleased to report that in all the countries visited I was cordially received and given excellent cooperation by representatives of the departments of agriculture, as well as civil and military authorities, only a few of whom can be mentioned by name. I am particularly indebted to Monsieur Monciero and Monsieur Wertheimer, chiefs of the two Algerian date experiment stations at El Arfiane and Biskra, respectively. These two men not only extended the use of all their facilities but gave freely of their time in the planning and execution of the project. I was fortunate in meeting Monsieur Monciero in Algiers and was able to accompany him to the date country of Algeria. I will never forget the hospitality and kindness of M. and Mme. Monciero in entertaining me for a month in their home at El Arfiane where there are no public facilities for travelers.

DATE AREAS OF FRENCH NORTH AFRICA

The date areas of French North Africa are all located south of the Atlas Mountains, the main system of which extends from a point near the Atlantic Coast in Morocco opposite the Canary Islands for about 1500 miles in a northeasterly direction to that point of the continental bulge in Tunisia which juts out toward Sicily. The principal date-growing districts are across the northern part of the Sahara where water from the snows and rains of the mountains becomes available in the desert through surface or underground flow. Most of the French Sahara is a plateau. There are many districts where dates are grown at elevations of 1000 to 3000 feet; but the most important area of all is the low desert of the vast interior basin which extends from eastern Algeria across southern Tunisia almost to the Gulf of Gabes. The lowest parts of this depression, some of which are below sea level, are relatively near to the southern foothills of the Atlas system and they are marked by a series of large shotts, or shallow salt lakes, formed by drainage which has no outlet to the sea. About half of Algeria's 6.9 million palms and about ¾ of Tunisia's 3 million palms, or a total of more than 5 million date palms, are located in this area. There are six large groups of oases in this low desert area: the Oued Rhir, the Zibans, Ourgla, and the Oued Souf in Algeria, and the Djerid and the Nefzaoua in Tunisia.

It is not proposed here to describe in detail the date culture of these oases or others that were visited during my travel in French North Africa. The Sahara is too vast and conditions too varied to be covered in one brief paper. Excellent accounts of date culture in different parts of the low desert area of French North Africa have been given by Kearney (3, 4), Swingle (7), and Hodgson (2), and there are several good French references (4, 5). Only some of the outstanding features of the Oued Rhir, probably the most important date-growing area in French North Africa, will be mentioned in connection with certain unique and distinctive characteristics of date culture there and in some of the other localities included in my itinerary.

THE OUED RHIR

The Oued Rhir should be of special interest to date growers in Coachella Valley. It was near Touggourt in the southern end of this district that, according to tradition, the Deglet Noor variety originated about the beginning of the 17th century. It was here that modern cultural methods were first applied to date culture by enterprising French colonists during the latter part of the 19th century and it was their example that furnished the primary inspiration for our own attempts to introduce date culture into the United States. All our large importations of offshoots of the Deglet Noor variety were obtained from the Oued Rhir. My comments about date culture in the Oued Rhir apply only to the French plantations unless otherwise specified.

The Oued Rhir is the pride of Algeria and is outstanding from the standpoint of modern cultural methods and the production of high-qual-

Table 1.—Average Daily Temperatures in Localities Where Dates Are Grown in French North Africa

		Maximum					Minimum	
	No. Yrs. record	June	July	Aug.	Sept.	year	Jan.	year
Touggourt, Algeria	15	99.0	106.3	104.2	96.8	83.5	38.1	57.7
Biskra, Algeria	15	96.6	104.2	102.4	94.8	81.4	43.3	61.0
El Kantara, Algeria	9	91.0	97.0	95.5	88.7	75.0	36.5	52.9
Gabes, Tunisia	40	82.6	89.4	90.9	86.4	75.9	42.8	57.4
Erfoud, Morocco	12	101.8	108.7	106.5	94.8	83.4	34.3	56.0
Indio, Calif.	25	102.1	106.5	105.5	100.6	88.3	38.6	57.6

Table 2.—Average Rainfall in Localities Where Dates Are Grown in French North Africa

	No. Yrs. record	July	Aug.	Sept.	Oct.	4 mos.	year
Touggourt, Algeria	16	.03	.00	.13	.15	.31	2.26
Biskra, Algeria	16	.10	.04	.59	.43	1.16	5.43
El Kantara, Algeria	16	.09	.24	.65	1.30	2.28	9.71
Gabes, Tunisia	10	.00	.08	.67	1.54	2.29	6.52
Erfoud, Morocco	12	.00	.08	.28	.47	.83	2.72
Indio, Calif.	53	.05	.22	.21	.18	.66	3.00

1. Horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

ity fruit for export. Oued is the French name for a desert river, usually dry, at least on the surface, except following winter rains. Rhir is the name given to deposits of salt found in the soil of this region. The Oued Rhir is not strictly speaking a oued today, but it follows in a general direction from south to north what is said to have been a stream bed in the quaternary, or glacial, epoch when there was much more rainfall in the Sahara. Its course is marked by a chain of about 60 oases of varying size extending from Blidit Amcur, 18 miles south of Touggourt, over a distance of about 80 miles to Ourir, 40 miles south of Biskra. About 2/3 of Algeria's 600,000 Deglet Noor date palms are located in this district.

The climate of the Oued Rhir is remarkably similar to that of the Coachella Valley. The mean maximum temperatures at Indio are slightly higher (Table 1). Although the annual rainfall at Indio is only ¾ inch higher than at Touggourt, when the records are examined as to distribution it is apparent that there is twice as much rainfall during the critical July-October period at Indio as at Touggourt (Table 2). This affords an index to the frequency of light showers and high humidity during the critical period when the Deglet Noor fruit is susceptible to checking. During the 1948 season in the Oued Rhir I failed to find a single date affected with blacknose and only very rare and slight traces of checking. Growers with whom I talked said that they did not expect rain damage oftener than about once in 7 years. Records at Indio show that it can be expected about once in 3 years.

The oases of the Oued Rhir are supplied with artesian water from wells 300 to 600 feet deep, and a few as deep as 1000 feet. These are flowing wells. Only a few of the French operators supplement the natural flow with pumps during summer. In fact, extensive use of pumps might cause serious dislocations in the present economy of the Oued Rhir by lowering the water table to where pumping might be necessary for all. The French plantations are all in large units, commonly with access to outside capital, and probably could stand the expense of pumping; but the native gardens are in relatively small units and the installation of pumps might involve serious economic difficulties. In the early days before the interrelation of the underground water supply of the various oases was understood, the drilling of new wells sometimes caused the flow in older nearby wells to stop entirely. A few localities were ruined before the true situation was realized. Now the drilling of new wells is prohibited without Government permit and such permits are not granted except for replacements in the maintenance of existing acreage. Consequently any appreciable expansion of the present acreage in the Oued Rhir seems unlikely, although some additional water might become available as a result of better conservation and more effective use of the present supply.

There is, of course, the possibility that previously untapped artesian strata may be discovered in other parts of the country. One such development is just getting underway at Zelfana, between Ourgla and Ghardaia to the southwest of the Oued Rhir, but the extent and character of the agriculture possible there will be experimental for some years to come. Agriculture in some of the districts near the foothills can be improved and the cultivated area increased somewhat by the installation of dams in the mountains. The French have envisioned such developments, and one new dam now nearing completion northwest of Biskra is expected to rejuvenate the declining date gardens and agriculture of Sidi Okba and surrounding territory.

Irrigation water in the Oued Rhir contains a high proportion of total salts, averaging about ½ of 1 percent, or about six times as much as is found in Colorado River water (7). Although this water is said to be too salty for citrus and some other crops, dates do very well if the soil is properly drained. Incidentally, the high salt content of the irrigation water in the Oued Rhir is believed to make Deglet Noor fruit darker than that grown in the Zibans near Biskra where the salt content is only about half as high.

Drainage is necessary because throughout the Oued Rhir at a depth of 3 to 6 feet there is a table of water much more saline than that of the artesian wells. Without drainage the water table rises and seriously interferes with tree growth. To provide drainage, narrow ditches 5 or 6 feet deep are dug between palms at intervals of 2, 3, or 4 rows. No water is applied between rows where a ditch occurs and usually over only 1/3 to ½ of the area between other rows. The average date grower in the Oued Rhir probably uses only about 4 to 6 acre-feet of water annually, or about half as much as is applied in the Coachella Valley.

The best gardens of the Oued Rhir are on soil which is typically fine sand for the first two or three feet with a clay admixture increasing below. These soils contain a relatively high percentage of gypsum and there does not appear to be any trouble with water penetration.

Cultural Practices: The preferred spacing of Deglet Noor palms in the French plantations of the Oued Rhir is 9 meters (29.5 ft.) each way. This distance is adequate under conditions there, for there is seldom an overlapping of leaves. From measurements in several of the best date gardens of the Oued Rhir, however, it appears that the average length of leaves is 2 to 3 feet shorter than those of the best Deglet Noor date gardens in Coachella Valley. Their experience confirms that of some of the pioneer date growers here that it is preferable to space palms so as to prevent pronounced overlapping of leaves when they are mature.

Pruning is confined to the removal of dead or dying leaves, most of which is done in September or early October just prior to the harvest. This is satisfactory under conditions there, but here it seems better to do most of the pruning before midsummer because of our higher humidity during July and August and the increase in checking and blacknose which has been shown to occur when there is an excessive number of leaves below the level of Deglet Noor fruit bunches. In general Deglet Noor palms in the Oued Rhir do not appear to carry as many green leaves as those in the better gardens of Coachella Valley.

Fruit thinning on the bunch is not generally practiced in the Oued Rhir. A few growers are experimenting with thinning and some cut back the tips of the strands enough to remove about 10 to 20 percent of the fruit, but at present they are the exceptions. In this connection, it was apparent that the unthinned bunches were not quite are large as unthinned bunches are here, although measurements were not made to sustain this observation.

No covers are placed on fruit bunches in the Oued Rhir, as there is not enough damage from rain or birds to justify their use. In the Biskra district, nearer to the mountains where the rain hazard is greater, experiments with bunch covers have been made at times in the past, but their use has not been adopted.

No one questions the need for fertilizer applications for dates. The standard program is to apply about 5 tons of manure per acre in late winter and about 5 or 6 kilos (11-13 lbs.) of commercial fertilizer per palm usually divided into three applications between December and June. Complete fertilizers appear to be most commonly used in such formulas as 10-10-20 that would give somewhat less than 1 lb. of actual nitrogen per palm according to the prescribed dosage; but at least one French grower at Tozeur, under conditions very similar to the Oued Rhir, was applying nitrate of soda at a rate of about 2 lbs. of actual nitrogen per palm in addition to manure.

Cover crops are not generally grown. I saw alfalfa between young palms in one French planting, but it had been planted primarily to provide forage for stock. Although the French seldom have other crops interplanted

with dates, some gardening is carried on between the palms by the natives — vegetable, apricots, pomegranates, etc.

Most of the French plantations are given one deep plowing after the date harvest to combat weed growth and in addition there are usually 2 to 3 light harrowings during the year.

HARVESTING: The Deglet Noor date harvest in the Oued Rhir usually begins about the last of October and is completed early in December. This is a much shorter season than in the Coachella Valley, for which there are two reasons. Climatic conditions are relatively uniform over the entire Oued Rhir without as much variation as in the much smaller Coachella Valley with its varying conditions of exposure and air movement due to high surrounding mountains. The second reason is that the dates are not picked individually, but all the bunches are cut at one time after the fruit is about 9/10 ripe. The bunches are cut by a laborer who climbs barefooted among the leaves, from which no thorns have been cut, and the bunches are passed by him down a human chain of laborers spaced at intervals along the trunk from the crown to the ground. The bunches are taken to a central part of the garden where the ripe fruit is removed. The small percentage of unripe fruit is left to ripen and cure on the bunches, which are hung up on racks either in specially constructed sheds or in rooms designed for that purpose. A few growers are equipped to use supplementary heat when it seems desirable late in the season, but it seldom appears necessary.

It is believed that this method of harvesting might bear further testing in the Coachella Valley. A few growers here have experimented with it in a small way, usually hanging bunches on the trunks of palms, occasionally leaving them in the covers lying on the borders, and some are convinced that fruit ripens better this way than if picked from the bunch before it is ripe. This procedure, as followed in the Oued Rhir, is less expensive than handling on trays in maturation rooms. The small percentage of unripe fruit that falls from the bunch in handling is usually placed on grading trays and stacked in a protected place to ripen. A few growers are experimenting with artificially heated maturation rooms for such fruit.

GRADING: The fruit picked from the bunches is placed on wire-bottom trays. The trays used at El Arfiane, apparently the standard in the Oued Rhir, measured 63.5 in. long, 31.5 in. wide, and 2.5 in. deep, with 7.5 in. handles projecting lengthwise from each corner to facilitate handling and 3-in. legs in each corner to raise the tray from the ground or from another tray on which it may be stacked. The fruit is graded on these trays by boys and men from about 15 to 70 years of age, and occasionally by old women, who usually work two to a tray. Boxes, which hold 25 to 30 kilos (55 to 66 lbs.) of fruit, are arranged along the sides of the trays to receive the different grades. There are commonly 6 separations: 2 grades of dry dates; 2 grades of the softer fruit; fruit not fully ripe; and culls. Except for the unripe fruit most of it would probably be classed as dry according to present standards in California. Grades vary somewhat according to the requirements of the different packing houses, nearly all of which are located in Marseilles, France. In some instances the packing house is under the same ownership as the plantation in Algeria. In France the fruit is regraded and packaged according to consumer demand and established practices.

The grading done in the Oued Rhir eliminates the culls and very low grade fruit, which are retained and utilized locally; and this is done by cheap labor. The possibility of eliminating culls and low-grade fruit by field grading may have possibilities here. It has already been done in a small way by a few growers.

PESTS: It may surprise growers here to learn that all this fruit is graded and packed in field cases without fumigation, although required by law to be fumigated before it is shipped out of the country. This is possible because there is actually very little insect infestation. I examined large numbers of dates and only in rare instances in cull fruit did I find insects. There appear to be several reasons for this. As previously mentioned, the climate of the Oued Rhir is drier during the ripening season than that of the Coachella Valley, and this discourages the nitidulid beetles. Partly perhaps because of the poverty and perpetual hunger of the native laborers, there is a very effective cleanup, and never did I see any waste dates lying around. For the same reason there are no waste fruits or vegetables which might serve as intermediate hosts. As previously mentioned, there are seldom any interplantings in the French gardens. Fruit stored locally without fumigation becomes infested with the larvae of certain moths similar to the Indian meal moth and the raisin moth.

The date mite, known in Algeria as the "Bou-Faroua," is considered their most serious pest. Dusting is regularly practiced, but instead of pure sulfur they prefer a mixture of 1 part sulfur with 2 parts of lime or gypsum. Two or three dustings are sometimes given beginning about June 1.

Parlatoria scale is everywhere in Algeria and Tunisia. Usually it appears to be kept fairly well in check by two predatory beetles, but in some locations, particularly those more exposed or a little on the dry side, I saw young leaves entirely covered with the scale and there could be little doubt but that it was causing some injury. In a few instances sprays are being used to combat parlatoria. The Deglet Noor variety appears to be more subject to this scale than the two other most common varieties, Rhars and Deglet Beida.

There are no serious diseases affecting date palms in the areas where the Deglet Noor variety is grown.

EXPERIMENTAL WORK WITH DATES IN ALGERIA

Two date experiment stations are maintained by the Algerian Department of Agriculture, one at Ain Ben Noui, a suburb about 5 miles west of Biskra, and the other at El Arfiane, 90 miles south of Biskra in the Oued Rhir. The Ain Ben Noui station comprises three separate gardens with a total of about 2000 palms, most of which were in bearing before they were acquired by the Government for the purpose of studying palm management and fruit handling. The El Arfiane station, established in 1918, has been developed entirely by the Government for the purpose of studying the problems involved in the creation of a date garden under the conditions peculiar to the Oued Rhir. In 1949 about 80 acres and 3200 palms were under cultivation. Both stations have been handicapped by lack of adequate appropriations and were largely inactive during the war years. Much of the work done has been along the line of demonstration and a considerable amount of the superintendent's time is taken up with extension work among growers.

The current research program at El Arfiane deals mainly with fertilization, irrigation, variety study, date breeding, offshoot production, use of growth substances, pollination, and fruit thinning. Most of this work was begun after World War II and has not been under way long enough to justify conclusions, but progress reports have been made covering certain phases of it.

Experiments with different frequencies of irrigation have shown that through the summer months in the Oued Rhir water should be applied every ten days for maximum palm growth and production and that longer intervals result in earlier ripening.

Different methods of pollination have been tried and the use of dry, sifted pollen blown through a long, light tube is considered promising for commercial use.

Fruit-thinning by cutting out the centers of bunches early in the summer has been found undesirable because it opens up the bunch too much and results in too much drying of

the fruit. This may be taken as additional evidence of lower humidity in the Oued Rhir in late summer than in the Coachella Valley. Reduction of the crop on a Deglet Noor palm in full production to about 12 bunches, unthinned except for a slight cutting back of strand tips in some gardens, is the current practice.

Application of various growth substances to flowers, fruits, and offshoots, have thus far given negative results.

Copper sulphate dust has been used satisfactorily for inflorescence rot.

VARIETAL STUDIES

I had two reasons for beginning my studies in French North Africa at El Arfiane. Not only is it in the center of the most important date district in French North Africa, but the experiment station has a collection of the more important varieties grown in Algeria. In a study of adaptation it is fundamental to know what varietal types have been evolved under different conditions. Sometimes an important variety is grown under different names in different localities, or conversely, the same name is given to different varieties in different localities. In early importations from Algeria we obtained more than 50 varieties whose identity has been uncertain because only a very few have been described in sufficient detail for verification. From my investigations in the Oued Rhir and the Zibans (Biskra), from which districts most of these varieties were obtained, it is now apparent that some of them were seedlings and not entitled to varietal status, but there is no longer any uncertainty about the established varieties. Upon my return to the United States this information enabled me to check the Algerian varieties which after many years' study in the United States had already been described in a manuscript, which will be published shortly. Altogether, in French North Africa I saw and described, in more or less detail, more than 200 varieties of dates, although after the date harvest it was usually possible to see only the palms and not the fruit. These included the principal varieties of the country; but there were probably about that many more that I did not see, some of which are important in the localities where they are grown but which I did not have time to visit.

OLD DATE PALMS

Some of the problems that will sooner or later confront all date growers in the United States are the productive life of the date palm, its ultimate height, and the changes that may be expected with age. I was interested in this study, not only because of its economic significance, but also because changes in palm characters associated with age and environment have sometimes caused confusion in the description and identification of varieties. Furthermore, if such changes can be recognized they may afford indices useful in research for evaluating the environment or conditions which produce them.

In Algeria I was able to secure some data on old Deglet Noor palms in the locality where, according to tradition, the variety originated about the beginning of the 17th century. Wherever observations were made on old palms, I searched for young palms nearby under similar conditions as a basis of comparison. The highest, and probably the oldest, Deglet Noor palm seen in French North Africa was near Touggourt. It measured 64 feet to the bud and was said by the gardener to be over 200 years old. The age, of course, is questionable, as the natives keep no records, but from appearances I am reasonably sure that it was considerably over 100 years. This old palm bore 8 bunches of fruit, and in the same garden there were 7 others almost as high, bearing 2 to 7 bunches each, or an average of 5.3 bunches per palm for the group. In this same garden a young palm, 9 feet to the bud, bore only 6 bunches.

The tallest Deglet Noor Palm found at Temacine, about 10 miles south of Touggourt, measured 52 feet to the bud and bore 8 bunches of fruit. It was probably over 100 years old and it was in a group of four other similar palms bearing 7 to 11 bunches each, or an average of 8.8 per palm. Nearby, a younger palm, 19 feet high and probably in its prime, bore 10 bunches.

The average size of the bunches on the old palms in both oases was estimated at about 8 lbs. of fruit, and those on the young palms apparently were not much larger. According to this estimate the old palms at Touggourt averaged about 42 lbs. of fruit and those at Temacine about 70 lbs. The young palms, however, were not bearing appreciably more fruit than the old palms. This may have been due partly to the difficulty of establishing young palms in an old planting and partly to some deterioration in soil or moisture conditions after the old palms were established. The gardens were rated as only fair. This raises the questions whether the production of the old palms may not have been lowered as much by unfavorable growing conditions as by old age, and whether the ultimate height of palms of the Deglet Noor variety may not exceed 64 feet under more favorable conditions. The ultimate height of a date palm at any age is known to be due partly to variety and partly to environment.

Fruit from the old palms when compared to that from young palms nearby was found to be slightly smaller in size (both fruit and seed), slightly lighter in color in the khalal stage, and slightly drier in texture when ripe. These differences were not large, but they were said by the natives to be characteristic.

Differences in the leaves were more striking than differences in the fruit. The leaves of the old palms were only about two-thirds as large as those on the young palms with comparable differences in the number and size of the pinnae and spines.

Inquiry among French planters brought out the general belief that Deglet Noor palms begin to decline in production at about 60 years of age; but in the only two plantations under French management where I found Deglet Noor palms as old as this, a deterioration in water supply could have accounted for most of the reported reduction in yield. One of the two, located at Tamerna where the first artesian well was bored by the French engineer, Jus, in 1852, had some palms about 50 feet high which were said by the manager to be 120 years old and to be producing about 100 lbs. of fruit per palm yearly in spite of a reduced artesian flow for a good many years past. As 220 lbs. of fruit per palm is considered a good average yield in the best gardens of the Oued Rhir, the reduction in yield of these old palms due to age was certainly not greater than 50 per cent.

THE OUED SOUF

No more unique and picturesque oases are to be found in French North Africa than those of the Oued Souf in Algeria near the Tunisian border. Several thousand small date gardens in the bottom of funnel-shaped depressions among high sand dunes mark the course of this oued. At a depth of about 3 to 6 feet below the level of the date gardens is water of quantity and quality sufficient to grow dates without surface irrigation. Offshoots are planted in the bottom of holes deep enough to place them about 1 or 1½ feet above the water table. Often the sides of these holes are lined with native plaster to prevent them from filling with sand. During the first summer the offshoots are watered by hand from a well that is situated on the side and a little above the level of the garden. After that no further irrigation is given and the holes are gradually filled up as the palm grows.

The palms seen by the writer in the better gardens of the Oued Souf appeared to be as healthy and vigorous as any in French North Africa. High quality Deglet Noor fruit is produced, but it tends to be a little dry and there are sometimes grains

of sand embedded in the flesh. The maintenance of these gardens requires a continuous struggle with the constantly encroaching sand. The sand which drifts into the gardens is carried in baskets on the backs of laborers or donkeys in an almost ceaseless procession to the crests of the dunes where it is dumped over windbreaks of palm leaves only to be blown back again by the next windstorm. Palms in the Oued Souf are said to produce few offshoots and the varieties grown represent the best of those of the Oued Rhir in Algeria and the Djerid in Tunisia, from which oases offshoots are imported from time to time.

DATE CULTURE ON THE MEDITERRANEAN COAST OF TUNISIA

At Gabes in Tunisia an important date culture has developed close to the sea. There are flourishing date gardens within two hundred yards of the beach. From springs located in the foothills a few miles inland there is an ample supply of good water for an oasis of 220,000 palms. Dates were already being grown at Gabes during the period of Roman occupation as they are mentioned by Pliny in commenting upon the fertility and luxuriance of this oasis, then known as Tacape. Date culture in the French Sahara was not established until after Berber immigrations of the 6th century A.D. and the Arab invasions a little later.

Although the date is the most important of the crops grown at Gabes the climate is distinctly marginal for date culture. The mean maximum temperature during the growing season is too low to ripen varieties like Deglet Noor and there is an increasing hazard of damage from rain in the fall (Tables 1 and 2). There are, however, three varieties of dates which are extensively grown throughout the oasis and which appear to be well adapted to such marginal conditions. All three—Kenta, Bouhatem, and Aguewa—are early-ripening dates of the dry type. They ripen before most of the fall rain and because of their dry character they are less subject to spoilage from rain than softer dates. Another variety of this same type, the Lemsi, said to be very salt-resistant, is grown to some extent on the Island of Djerba about 60 miles east of Gabes. Later, after my return to Algeria, I found at El Kantara, another marginal locality in the foothills north of Biskra, still another variety, the Bouzeroua, which is very much like the Kenta and which was evolved under somewhat similar climatic conditions.

Date culture is also adapted to marginal conditions at Gabes by the arrangement of the plantings. The palms are not planted in the usual orchard form, but in rows around an open square or rectangle which may average from as small as about ⅛ acre to about ½ acre or more in size. Usually there are two rows of dates, one on each side of an irrigation ditch, with the palms spaced 10 to 15 feet apart in the rows. In the open centers are grown a large variety of vegetables and fruits. This arrangement affords light and aeration on one or both sides of the palms and serves to minimize losses from fruit rot and to reduce the incidence of graphiola fungus which occurs on date leaves throughout the oasis and is evidence of continuously high humidity. The intercultures also have their proportion of light and exposure. This same system of planting dates was later found in Elche, Spain.

This method of planting dates in widely spaced rows with low-growing crops between could undoubtedly be used to advantage in the more humid localities in the United States, such as Salt River Valley, Arizona, and southwest Texas.

THE BAYOUD DISEASE IN MOROCCO

I went to Morocco primarily to visit the home of the Medjool date and to see the bayoud disease and observe firsthand its effect on date culture and date varieties. In Rabat, the capital, I met Monsieur Cuenot, Directeur du Service du Horticulture, and Monsieur Guillot, Directeur du Centre de Recherches Agronomiques, who very kindly arranged with local representatives of the Moroccan Department of Agriculture to facilitate my travel and studies in the districts visited. I also had the pleasure of talking with Dr. Georges Malencon who has devoted considerable time to the study of the bayoud disease and who believes that he now has sufficient evidence to prove that it is caused by a fungus, *Fusarium albedinis* (Killian and R. Maire) Malencon. Two young men from the Department of Agriculture, Monsieur Benson, horticultural inspector, and Monsieur Pereau-Leroy, geneticist, accompanied me a day's journey by bus across the Atlas Mountains to Ksar-Es-Souk, from which point we traveled in an auto furnished by Monsieur Billotte, agricultural agent in that district.

The two most important districts where dates are grown in Morocco are the valleys of the Ziz and the Draa south of Atlas Mountains and most of Morocco's 2.9 million date palms are about equally divided between them. Time did not permit a visit to the Draa, the more southerly of the two.

A short distance above Ksar Es Souk the Ziz river emerges from a precipitous and picturesque gorge and works its way 40 miles south across a bare, rocky plateau, forming a very narrow valley abruptly lowered from 100 to 300 feet below the general level. Then it passes out to a broad, fertile valley known as the Tafilelt, at the head of which is the town of Erfoud. The elevation of Ksar-Es-Souk is 3445 ft.; that of Erfoud, 50 miles south, is 2625 ft. In spite of its higher elevation the mean maximum temperature and the annual rainfall at Erfoud are remarkably similar to those of Touggourt (Table 1 and 2).

The valley of the Ziz between Ksar-Es-Souk and Erfoud is the home of the Medjool date. Prior to about 1920 this variety is said to have constituted about 25 per cent of the palms grown in this district. Now it must be considerably less than 1 per cent. In six days of travel up and down the Ziz river from above Ksar-Es-Souk to below Erfoud we found less than a dozen palms of the Medjool variety and these were all young palms, usually offshoots surviving where the parent palm had been killed by the bayoud. Unfortunately this variety is very susceptible to the disease and in its native home the Medjool is apparently actually threatened with extinction. At the time of my visit the fruit had long been harvested, but I was shown two or three obviously different types of palms under the name of Medjool, only one of which represented the variety introduced in 1927 by Swingle which has produced fruit agreeing with descriptions and photographs of this variety. There are now so few Medjool palms in this district that I suspect that the varietal type is actually not well known to the younger generation, and probably any of the seedlings of this variety that produce similar fruit go under the same name.

It is a sad story. In this district that was once planted solidly to dates the palm population has probably been reduced at least 50 per cent. Except in a few spots here and there, date palms no longer dominate the scene, but occur as scattered specimens in fields of grain or among plantings of olives which have to a considerable extent replaced them. A few varieties are said to be relatively resistant to the disease, but the fruit is so inferior that there is little incentive to plant them.

Descriptions of the bayoud disease will be found in papers by Swingle (8) and Fawcett (1) in early reports of the Date Growers' Institutes, but a few of the outstanding facts about the disease will bear repetition. The late Dr. Fawcett spoke of it as the worst disease he had ever seen on any plant. Coming from one of the world's most eminent pathologists, that is a strong statement.

The word "bayoud" means white and is applied to the disease because

of the characteristic color of affected leaves. The first symptom usually appears in late spring or early summer on a palm otherwise healthy to all outward appearances; a single leaf, which may be located in any part of the crown, will turn white quite suddenly, sometimes in two days' time. Usually the pinnae on one side of the leaf are affected first and their white color makes a striking contrast with the apparently normal pinnae on the other side. This condition persists for only a short time, however, as the entire leaf soon withers and the symptoms spread from leaf to leaf until the entire crown is affected and death results. Some leaves lose their green color more slowly, and gradually become yellowish, with long, irregular brown streaks along the rachis. Thrifty palms, in light soils, with ample water often die within two months after the first symptoms appear, but neglected palms in heavy soil with an inadequate water supply are said to survive sometimes as long as two years.

The bayoud disease has been endemic in the valley of the Draa for a long time and apparently resistant types of date palms have been evolved that are not seriously injured by it. Sometime around the turn of the century the disease had begun to move north and east. During the next thirty years it spread throughout the Tafilelt region and up the valley of the Ziz. It is now present throughout all the date country of Morocco. The oases of Beni Ounif and Colomb Bechar and In Salah in western Algeria represent the extreme eastern point of its extension up to 1949.

There is no known remedy for the bayoud disease. Its presence in Morocco and western Algeria is an ever-present threat to the very important and highly developed date industry of eastern Algeria and Tunisia, and indirectly to all the date-growing areas of the world. The government of Algeria has imposed quarantines against the importation of offshoots or any palm products from the infected areas. Dr. Malencon believes that the bayoud spreads naturally for the most part through the soil from root contacts; but the fungus survives for months in the woody tissues of the palm, and man has probably been the chief vector in the occasional long jumps that it has made, by transporting offshoots, palm wood, or leaf midribs. It behooves other date-producing countries to keep a watchful eye on the progress of the disease.

DATE CULTURE IN SPAIN

Except for one much smaller and less important planting near Bordighera, Italy, the only commercial date culture in Europe is located near the southeastern coast of Spain at Elche, near the port of Alicante and in the province by this name. In this locality were 98 percent of the 220,000 date palms in orchard plantings in Spain in 1945, according to statistics of the Department of Agriculture. Date palms have probably been in Spain since Phoenician times; they are mentioned by Pliny; and it may be more than a coincidence that the plantings at Elche are arranged in rows around an open center rectangle in much the same manner as at Gabes, Tunisia, as has already been mentioned. The occurrence of more graphiola fungus on date leaves at Elche is an indication of somewhat higher humidity than at Gabes.

Although dates are the most important crop at Elche all palms are grown from seeds. In recent years a few attempts have been made to plant offshoots, but I was told that offshoots were hard to transplant. This may be because they have not worked out the proper technic. While offshoots would root better in a lighter soil than the stiff clay which prevails at Elche, palms grow very well on this heavy soil, better, it is said, than on sandy soil. Seeds are usually planted in nurseries and the young palms transplanted later; but a few seedlings often come up around the old palms and some of these are also used.

Since they are all grown from seeds there is an enormous variation in the fruiting palms both as to time of ripening and character of fruit. Although most of the fruit is harvested from September to December there are at least a few fresh dates to be had locally the year round. When I was there the 2nd week in April, 1949, pollination was in full swing, but I saw a few bunches of fruit on occasional palms in many gardens, and in one instance the owner pointed out a palm on which the fruit was still green and which he said would ripen in early summer. As would be expected, most of the fruit is very inferior.

After a palm comes into bearing the fruit is classified into curing and non-curing types. The curing dates are those that will ripen naturally and dry down to a point where they will keep for 3 or 4 months. Bunches are often cut and hung in the sun to ripen. The non-curing dates are low in sugar per volume of fruit and must be eaten fresh. There is another type, apparently somewhat intermediate, which is ripened by a special process in which vinegar is used. According to a demonstration I witnessed, about 20 pounds of khalal dates are placed in a large basin with about a cupful of vinegar. The fruit is stirred thoroughly so that all the dates come in contact with the vinegar. Then the vinegar is poured off. It is said to be undesirable to have drops of vinegar adhering to the fruit. The moistened dates are placed in a barrel or box on the bottom of which has been placed a layer of green date leaflets. The process is repeated until the container is nearly full of fruit. A cloth is placed on top of the fruit and on the cloth pieces of cement or stones. The acetic acid fumes from the vinegar remove the astringency and soften the fruit in from a few hours to 2 or 3 days according to the weather and the character of the fruit.

One probable reason why seedling dates are grown in Elche is that the male palms are a source of income. They are used to supply leaves for Palm Sunday celebrations throughout Spain and other parts of southern Europe and a few leaves are said to be exported to North America. This is a unique industry developed in the early centuries of Christianity in Spain. To prepare the leaves for these celebrations they must be blanched. Blanching is accomplished by tying up the leaves in a compact bundle around the bud a year in advance so that all the new leaves that emerge during that period develop without light and lack the green pigment that comes with normal exposure. Leaves are tied up from February to April. A few additional leaves cut from other palms are added to make the covering more effective. In midsummer a second wrapping of leaves is added at the top to protect more effectively the new growth that has begun to push out. The operations involved in the blanching of leaves require some skill and experience and the men who do the work are paid higher than average wages. The yellowish-white, unexpanded leaves are cut and marketed before Palm Sunday. A palm is left three years to grow leaves before the operation is repeated, so it requires four years to produce one crop of blanched leaves. On Palm Sunday nearly every household in Spain will have one or more of these leaves and there seems to be a friendly rivalry in trying to plait the pinnae along the midrib in various designs to make them more ornamental.

For assistance in arranging for my visit to the date-growing district of Spain I am indebted to Sr. Eladio Asensio Villa, Chief of the Office of Foreign Agricultural Relations of the Spanish Ministry of Agriculture.

LITERATURE CITED

1. *Fawcett, H. S., 1931. Observations on the Culture and Diseases of Date Palms in North Africa. Date Growers' Inst. Rpt. 8:18-23.*
2. *Hodgson, R. W. 1932. Date Culture in Tunisia — Miscellaneous Observations Elsewhere in the Mediterranean. Date Growers' Inst. Rpt. 9:7-12.*
3. *Kearney, T. H. 1905. Agriculture Without Irrigation in the Sahara Desert. U. S. Bur. Plant*

Industry Bul. 86, 27 pp., illus.
4. *Kearney, T. H. 1906. Date Varieties and Date Culture in Tunis. U. S. Bur. Plant Industry Bul. 92, 112 pp., illus.*
5. *Lehuraux, L. 1945. Le Palmier-Dattier du Sahara Algerian. 138 pp., illus., Algiers.*
6. *Monciero, A. 1947. Etude Comparee Sommaire des Differents Types de Culture du Palmier Dattier en Algerie. Fruits d'Outre-Mer: 2:374-382.*
7. *Swingle, W. T. 1904. The Date Palm and Its Utilization in the Southwestern States. U. S. Bur. Plant Industry Bul. 53, 155 pp., illus.*
8. *Swingle, W. T. 1929. Date Culture in Southern Morocco. Date Growers' Inst. Rpt. 9: 7-12.*

JAMES C. WOOD: Chairman Afternoon Session

President, Arizona Date Institute, and Date Grower

Mr. Hutchinson, members of the California Date Institute, and guests, I am highly appreciative of the honor in being asked to serve as the Chairman of this afternoon session of the 27th annual meeting of the California Date Growers Institute. Mr. Hutchinson has asked me to open the session with a few comments on the date industry in Arizona.

In name, it would appear as though we in Arizona are in close competition with the date growers of California. In fact, this is really not the case at all. Here in California, you major in the production of the Deglet Noor date. The characteristics of this variety make it ideal for mass production methods in garden culture and for bulk marketing. Here, it would appear that large production is a distinct asset. Your fruit lends itself well to bulk shipment and to display and selling from stores and markets.

In Arizona, on the other hand, we have specialized in the growing of the soft varieties which seem to thrive better under the conditions of heavier soil—and less available water —which we have in Arizona. The production and marketing of these fresh dates entails endless hand labor. The thinning and picking elements of the cost of production, added to the expense of maturation and storage place our costs far above the plane on which excellent Deglet Noors can be produced. Added to this is the fact that the crop produced by the palms of our varieties is far short of that produced by the average Deglet Noor palm.

Experience has taught us that our fruit is most attractive at a moisture content that does not lend itself to bulk packaging and to the placing of the fruit on the shelves of retailers for resale. Our product is definitely at its best when shipped directly to the consumer. This means that our sales efforts may best be spent in the line of smaller sales to individual customers. This naturally adds to our selling cost per pound of fruit produced.

It is my observation that the raising and marketing of fresh dates in Arizona seems to be best handled by the relatively small producer. By that, I do not mean the individual who has a few palms in his yard, but rather to the grower who has from 200 up to say 700 palms. The raising and processing of fresh dates requires endless personal attention. When the volume of production reaches a point where considerable outside labor is necessary, the costs seem to rise to a point where profitable production is not possible.

While on the subject of costs and profits, it might be well to dwell briefly on the point of selling prices. We, in Arizona, as well as many of the growers in California, seem to be faced with lowering price scale for our fruit, in spite of the fact that our labor costs and the prices of everything we have to buy in growing and marketing the dates have substantially increased from the pre-war level. It is my feeling that our main failure is along the lines of marketing and salesmanship.

A condition which has existed in Arizona, and I believe to quite an extent in California as well, has been brought about by the so-called dumping of surplus fruit towards the end of a season. This fruit usually ends up in the hands of a class of merchandisers whom we call "scavengers" over in Arizona. Most of these are chiselers of the first water. They place the fruit on the market early the following season. They have nothing invested in garden or processing equipment. They bought the fruit for a song and can re-sell it at a ridiculously low price and still show a profit on their deal. The net result is that the price for the new crop is often established by these prices quoted by the scavengers, prices which are not based upon legitimate costs, prices at which no responsible grower of fruit can possibly compete.

I realize that the temptation is strong to try to cash in on fruit that you have on hand. I know, too, that it looks as though even a few cents per pound is better than nothing. This point, however, must not be overlooked. When you dump your fruit into the hands of these chiselers, it is going to show up again, and to your own detriment. You are cutting not only your own throat, but those of your friends in the date industry as well. I know of a lot of California fruit that came into Arizona this past season that was purchased on a basis that enabled them to sell the fruit at very low prices, and still leave the scavengers a nice profit, made at your expense.

When you analyze the situation, it seems hard to understand why this surplus exists. Millions of pounds of dates are imported into this country each year, as you well know. You find these dates on the market shelves in competition with our own home grown fruit. Dromedary dates sell. We all know that. And yet, when you convert the price on this seven ounce package into a price per pound, we find a selling price that usually ranges from 54 to 57 cents a pound. In the face of this, why should we find in many markets excellent Deglet Noors, grown right here in California, selling for less than 30 cents a pound? And why, I ask you, should there be a surplus which gets into the hands of men who demoralize our own markets?

A word about the date industry as it exists at the moment in Arizona. Most of our gardens, particularly the more recent plantings, have been badly burned by the freezes of the past two winters. We have lost so much of our green leaf area that most of us will probably produce less than sixty per cent of a normal crop. In addition, many growers apparently left too much fruit on the palms last year, with the result that many of the palms are showing no bloom at all this year.

Under normal conditions, gardens that are available for production at the present time should produce about a million pounds of fruit a year. When all of the plantings in Arizona attain full production, our output should approximate two million pounds a year.

At the moment, some of our plantings have gone out of production. Except in a few minor instances, the palms have not been pulled out. Although the present owners do not feel that profitable operation is possible under present conditions, nevertheless, the palms are still there and production is still possible in future years.

The sole purpose of the Arizona Date Institute has been to try to improve the quality of fruit produced. To this end, we have tried to improve cultural practices in the gar-

dens and to improve processing and storage methods. It is our desire to extend our efforts to the extent of trying to make the public a bit more date conscious, and to remove from the market fruit which is unfit for human consumption.

It is the desire of the date growers of Arizona to work with you California growers to the fullest possible extent. We realize that your problems are our problems. We appreciate very much the friendly cooperation which has been extended at all times to us by your Institute and its individual members. We hope that we can be of help in settling the problems that have arisen.

INVESTIGATIONS ON HARVESTING DEGLET NOOR DATES INCLUDING BUNCH CUTTING AND DELAYED PICKING

G. L. Rygg

Plant Physiologist, Division of Fruit and Vegetable Crops and Diseases
U. S. Department of Agriculture, Pomona, California

The work reported in this paper was done mainly on the 1942 crop, and was initiated in response to requests for information on methods of harvesting dates in the face of a greatly reduced labor supply. Two general procedures were followed. One method consisted in cutting the bunches while some of the fruit was immature and completing the ripening process while the fruit remained attached to the bunches. Paralleling this method, other bunches were stripped while a considerable portion of the fruit was immature, and the fruit was ripened in trays. Some study was also made of the effect on grades resulting from reducing the number of pickings to one or two.

Artificial stimulation of the ripening processes in harvested dates has been used in varying degrees over a long period of time. In locations that permit natural ripening on the palm the practice of picking before ripening has progressed to a considerable degree is likely to result in a sacrifice in the quality of the finished product.

It was realized at the start of this work that a lowering of the quality of the product was likely to be experienced, but if some way could be found by which a substantial portion of the crop could be saved which otherwise would be lost, the effort would be justified. Even the experiments that failed to yield an acceptable product would be justified by the fact that they would serve as warnings to those who might be tempted to try those methods, and thus save them the expense of having to learn these facts individually through their own failures.

CONDITIONS FOR RIPENING

It is difficult to arrive at satisfactory ripening conditions. If the humidity is too low the fruit shrivels and fails to ripen. Such results were obtained on several bunches which were held at 45 to 50 per cent relative humidity and 80° F. On the other hand, if the humidity was maintained high enough to prevent shriveling (70 to 80%) the product became dark and was inclined to be sticky. Of the two choices, the latter seemed to be the only one having a possibility of being practical. An attempt was also made to simulate the moisture relations on the palm by holding the cut bunch in a warm room (90° F.) with a low humidity (30%) and preventing shriveling by supplying water to the cut end of the fruit stalk. This experiment failed because of the failure of the water to enter the stalk. Apparently the conducting vessels were plugged early in the experiment. The ripening conditions which were provided for each bunch are shown in table 1.

MATURITY OF THE BUNCHES

A major consideration in attempting to ripen fruit on cut bunches is the degree of maturity a bunch should attain before it is cut. In the course of the season the maturities of the bunches that were cut were such that the ripe fruit ranged from 12 to 59 per cent of the total fruit at the time of cutting. While the evidence obtained during a single season is insufficient to serve as a basis for sound conclusions, there is a suggestion that in the early part of the season at least 50 per cent of the fruit on a bunch should be tree ripe before the bunch is cut. By the latter part

Table 1.—Conditions Used in Ripening

Bunch No.	Date	Temperature	Relative humidity	Ethylene	Remarks
		°F.	Percent		
1	9/25	80	70	1:10,000	Pollinated 3/12
2	9/25	80	45	none	Pollinated 3/16
3	9/25	80	70	1:10,000	Pollinated 3/31
4	9/25	80	45	none	Pollinated 3/31
5	10/1	90	60	1:10,000	100° and 80% after 10/12
6	10/1	80	60	1:10,000	100° and 80% after 10/12
7	10/1	80	....	none	.....
8	10/1	75	....	1:10,000	.....
9	10/1	80	45	none	.....
10	10/13	90	75	none	100° and 80% after 10/20
11 & 13	10/13	90	75	none	100° and 80% after 10/20; 90° after 10/27
12	10/13	90	75	1:5000	100° and 80% after 10/20; 90° after 10/27
14	10/20	100	80	none	.....
15	10/28	100	80	none	.....
16	10/28	90	80	none	.....
17 & 18	10/28				
A.		100	80	none	.....
B.		90	80	none	.....
19	11/12	90	70	none	.....
20	11/12	90	70	none	.....
21	11/12	90	30	none	Water supplied to cut end of stalk
22	11/12	90	30	none	Water supplied to cut end of stalk

of the season comparable results may be obtained if only 25 per cent of the fruit on a bunch is ripe when it is cut. In any event, when harvested too soon the quality of much of the product is lowered both by having an inferior flavor devoid of the aroma characteristic of the variety and by having a color considerably darker than that associated with good quality in the variety. The flavor of all the fruit was sweet with the exception of the last picking from bunches that were cut when only a small fraction of the fruit was ripe, e.g., bunches 3, 6, and 19 (tables 2 and 3).

RELATION BETWEEN SUGAR CONTENT AND QUALITY OF DATES

The impression is common among date growers that dates which are allowed to ripen naturally on the palm have a superior quality because they have had an opportunity to "sugar up," whereas premature picking is conducive to poor quality since the fruit does not have an opportunity to attain a sufficiently high sugar content. It has been found in earlier work that Deglet Noor dates that have ripened to the extent that they have softened to the equator are likely to have as much sugar in percentage of dry matter as the fully tree ripe fruit[1]. It is even sometimes true that fruit in the khalal stage has as high sugar content as ripe fruit on the basis of percentage of dry matter. In the current work it was found that fruit which ripened on cut bunches on succeeding weeks contained practically the same sugar content throughout the ripening period, although the eating quality gradually deteriorated (tables 2 to 4). Even the last picking, which often failed to ripen into a product that was at all acceptable, frequently contained as much sugar as the earlier pickings of excellent quality fruit. In those bunches that were cut when only a few ripe fruit had appeared the percentage of total sugars dropped noticeably in the last picking (bunches 3, 19, and 20, table 4). Even in these instances the total sugars amounted to 76, 75, and 78 per cent, respectively.

There was no relationship between the degree of inversion of sucrose and the quality of the fruit (tables 2 and 4). The last picking from a bunch was invariably of low quality, but the reducing sugars in such picking constituted from 23 to 62 per cent of the total sugars.

STRIPPING IMMATURE BUNCHES

In conjunction with ripening dates on cut bunches, it was desirable to

1. Rygg, G. L. Compositional changes in the date fruit during growth and ripening. U. S. Dept. Agr. Tech. Bull. 910. 1946.

Table 2.—Quality of Fruit of Successive Pickings from Cut Bunches

Pickings	Bunch numbers						
	1*	3*	6	15	16	19	20
1	good	good	good	good	good	good	good
2	good	good	good	good	good	good	good
3	fair	fair	good	flat	flat	good	good
4	fair	fair	fair	flat	flat	poor	poor
5	poor	poor	poor	poor	poor	poor	poor

*The first picking on bunches 1 and 3 was made one week after the bunches were cut; otherwise the first picking was made at the time of cutting.

Table 3.—Percentage of Fruit Ripe at Each Picking

Pickings	Bunch numbers						
	1*	3*	6	15	16	19	20
1	65	23	15	59	39	12	22
2	13	18	25	25	42	31	33
3	6	13	19	10	14	23	26
4	7	20	20	5	3	19	14
5	9	26	21	1	2	15	5

*Same as footnote to table 2.

Table 4.—Sugar Content of Dates Ripened on Cut Bunches and Picked at Approximately Weekly Intervals After the Bunches Were Cut.

Bunch	Picking	Percent sugar			Percent of total sugar as reducing
		Reducing	Sucrose	Total	
1	1*	32.5	46.4	78.9	41
	2	34.1	47.3	81.4	42
	3	29.8	50.2	80.0	37
	4	33.6	44.8	78.4	43
	5	49.1	30.4	79.5	62
3	1*	31.8	46.5	78.3	41
	2	37.0	39.8	76.8	48
	3	30.9	48.6	79.5	39
	4	36.4	31.9	79.9	46
	5	45.6	30.0	75.6	60
6	1	26.4	51.9	78.3	34
	2	30.6	47.6	78.2	39
	3	29.0	51.2	80.2	35
	4	30.4	48.5	78.9	39
	5	40.8	38.1	78.9	52
15	2	31.6	46.0	77.6	41
	3	38.9	42.4	82.3	47
	4	25.1	55.6	80.7	31
	5	18.5	61.2	79.7	23
16	2	33.6	44.9	78.5	43
	3	33.0	47.6	80.6	41
19	1	27.0	51.2	78.2	35
	2	30.4	47.5	77.9	39
	3	33.4	44.9	78.3	43
	4	33.2	44.0	77.2	43
	5	20.2	55.2	75.4	27
20	1	25.8	52.4	78.2	33
	2	30.1	50.3	80.4	37
	3	31.6	49.1	80.7	39
	4	32.9	46.9	79.8	41
	5	21.7	56.1	77.8	28

*The first picking on bunches 1 and 3 was made one week after the bunches were cut; otherwise the first picking was made at the time of cutting.

Table 5.—Ripening of Fruit Stripped from Bunches

Bunch No.	Date of picking	Maturity	Portion of bunch unripe when picked	Fruit failed to ripen	Portion of bunch failed to ripen
			Percent	Percent	Percent
11	10/14	Partly ripe	77	4	45
		Khalal		91	
13	10/13	Partly ripe	61	4	22
		Khalal		52	
14	10/20	Partly ripe	73	30	33
		Khalal		95	
17, 18	10/28	Partly ripe	28	16	11
		Khalal		95	

make a comparison with dates of similar maturities ripened after they had been stripped from the bunches. After the bunches had been picked clean the fruit was sorted into khalal, partly ripe, and ripe. The ripe fruit was untreated and the other lots were placed in the same ripening rooms with the lots still attached to the bunches. Tables 3 and 5 give a summary of the results. Very few fruits ripened if they were removed from the bunches in the khalal stage, whereas most of those that had begun to ripen when they were removed continued to ripen (generally from 70 to 90%), although the product was not always satisfactory. In general, about one-third to one-half of the fruit that was not ripe when picked failed to complete the process in the ripening rooms. This compares with an average of 16 per cent for fruit that was ripened on the cut bunches. From 11 to 45 per cent of all the fruit that was stripped from the bunches failed to ripen, as compared with 1 to 26 per cent for fruit that was ripened on cut bunches. In each instance a larger proportion of the fruit from the more mature bunches ripened than from those less mature.

A factor of perhaps greater importance than the amount of fruit that will ripen under the two methods of handling is the relative loss from diseases. While no accurate records were taken, the loss from the cut bunches was negligible, whereas the loss in fruit stripped from the bunches at either the khalal or partly ripe stage frequently amounted to 50 per cent.

EFFECT OF ETHYLENE

A number of reports in the literature show that ethylene will stimulate the ripening of dates. However, there was a belief to the contrary among some packing house operators. In order to obtain some information on which to base a conclusion as to the possible benefits to be obtained from the use of this gas some experiments were conducted. The gas was introduced rapidly until concentrations of 1:10,000 and 1:5000 were reached (by calculation), and subsequently a slow stream was maintained at rates calculated to maintain the respective concentrations. The results led to the conclusion that there was no response that had any practical application.

EFFECT OF CARBON DIOXIDE

A few experiments were conducted in which 10 to 15 per cent concentrations of carbon dioxide were maintained around the fruit. This was also without noticeable effect with the exception that khalal fruits were ruptured considerably more when held in high concentrations of carbon dioxide than when held in normal air, the relative humidity being maintained at 80 per cent by means of an appropriate concentration of sulfuric acid in both instances.

REDUCING FREQUENCY OF PICKING

An alternate method of reducing the labor involved in harvesting dates is to reduce the number of pickings made in a garden. Commercial harvesting during the season was reduced to fewer pickings than is customary because of the scarcity of labor and also because of the character of the season, which began late and ended at about the normal time, thus telescoping the harvest into a period shorter than usual. In addition, the season was drier than often is the case so that it was possible to leave the fruit on the palms longer after it was ripe than would be the case in a more humid season. Two or three pickings were the rule, in comparison with a normal of about five.

Table 6. — Effect of Reduced Frequency of Picking Upon Grades.

Grade	Lot A	Lot B
	Percent	Percent
A	0.58	0.92
B1	4.86	5.04
B2	55.65	22.57
C	17.76	45.70
D	18.10	20.96
Culls	3.05	4.81

The result of the reduced frequency of picking was largely that of an increase in the percentage of dry dates. The percentage of top grade dates was not reduced much if any, nor was there much increase in culls. An indication of the trend produced by this practice is shown in table 6, taken from information provided by Mr. W. W. Cook.

A fair comparison of the total yields obtained when different numbers of pickings were made is not possible, since properly matched plots were not available for comparison. From the data by Cook referred to above, lot A gave an average yield of 231 pounds per palm and lot B, 218 pounds. This suggests a slight decrease in yield when only one picking was made. These were not matched plots and no conclusions can be drawn, but the results are reasonable in view of the increased proportion of dry dates when only one picking was made.

FREEZING TO PROMOTE RIPENING

Several years after this work was done (1948) a progress report by Morris and Godfrey of the Texas Agricultural Experiment Station was received in which was described a method for hastening date ripening by freezing.

In 1949 this method was tried on Khadrawy and Barhee. It was not tried on Deglet Noor. It was found that freezing at —10° F. materially hastened subsequent development of the translucence associated with ripening and that the flesh softened considerably. The resulting quality, however, did not approach that found in dates that had been permitted to complete, or nearly complete, the ripening process while attached to the palm. This method will undoubtedly prove very helpful for saving dates in marginal areas where normal ripening can not be relied upon, but there is little likelihood that it will be of any value in important date growing sections.

SUMMARY

It would appear that, whenever the weather of the season permits, it is more practical to cope with the shortage of labor for harvesting by reducing the number of pickings, rather than by cutting the bunches and ripening much of the fruit artificially. This conclusion is based on the following considerations:

1. Considerable labor is involved in cutting the bunches and hauling them to the curing rooms.
2. Few growers are equipped with curing rooms. Reasonably well

insulated space with facilities for controlling temperature and humidity is required in curing cut bunches.

3. The quality of the product leaves much to be desired when the dates are ripened on cut bunches, although it is superior to that of correspondingly immature fruit that has been ripened after removal from the bunch.

A consequence of fewer pickings is an increase in the proportion of dry dates. This increase may be considerable. At present there is no entirely satisfactory method of preparing this type of date for the market.

OBSERVATIONS ON THE BAJA CALIFORNIA DATE INDUSTRY

Leland J. Yost

My observations on the Date Industry in Baja California are very incomplete, as both of my trips to the lower part of the Peninsula have been when the harvest season was far along and time has been limited. Next year I hope to be there at an earlier date, and to give more detailed information.

The main points of production are San Ignacio, Mulege, La Purisima and Comondu. Loreto and a few other locations have a limited planting, mostly for local consumption. These spots are true oases being watered locations surrounded by desert with agriculture confined to the arroyo bottoms where surface flow is available. Plantings are strictly limited to either the available land or the available water. In San Ignacio, water is the limiting factor and in La Purisima, it is land.

I do not know how many acres of palms are planted in any district, nor could I find anyone who had any idea of acreage or of the number of palms bearing. In 1923 the U.S. Department of Commerce reported a total production of 1,774,300 pounds with the majority coming from San Ignacio and Mulege. In my opinion production is even less today.

Dates were introduced to Baja California by the Padres of the Jesuit Order when they first entered the Peninsula, and were planted at each Mission as it was established. The Jesuit Historian, Father Clavajero, refers to the planting of Arabian date palms. Arthur Walbridge North, in his *The Mother of California,* written in 1906, states "upon the introduction of Arabian date palms into California, he arranged that San Ignacio should receive her full share of the first assignments. As a result thereof, three varieties of date palms soon reared high their green boughs in the Arroyo of San Ignacio." This would indicate the introduction of offshoots of known varieties. However, when consideration is given to the transportation problems of the early 1700's, and the dates of today have been viewed, it seems likely, that North was in error and that the introduction was seed and that quite probably from Spain. Further research on this point is now underway.

In general it might be said that the production of dates has been left largely up to nature with a minimum human interference. Trees are not planted nor offshoots propagated. When a seedling comes up if in a desirable opening, it is allowed to grow. When a tree dies it is removed and in time is replaced by a chance seedling. Offshoots are destroyed as a nuisance. Both the Washingtonia filifera and robusta are allowed to intermingle with the date palms, as the fans are much used for thatch roofing. Openings in the groves are often planted with a few fig or orange trees or perhaps a small number of grapevines of the Mission variety. The visual effect of such a jungle arrangement is pleasing, especially after 400 miles of barren desert, but from our viewpoint, is as inefficient an arrangement as could be conceived.

Hand pollination is not practiced as ample males are allowed to grow throughout the gardens to naturally pollinate the crop. At least all the dates I have seen seem to be pollinated and every grower that I talked to, denied ever giving the bees a hand in this, to us, important operation.

Ladders are not used, men climb low trees by using the leaf bases for hand holds, while tall trees are climbed barefoot with a rope sling around the tree. The entire fruit bunch is cut at one time and slid down a rope to the ground.

All trees are overpruned, just to make it easier to harvest the fruit, although the use of the leaves in building may have some influence on this practice. The fruit is harvested when it shows a golden yellow color, very similar to our Zahidi; is maturated in piles under palm leaf matting, dried in the sun on palm leaf racks and goes through a sweat in large palm leaf baskets. The majority of the fruit is thin walled, very full of white rag, has an exceptionally large seed and a very bland flavor. Sugar is of course low, due to harvesting while immature. The fruit is sold at the point of production to buyers for cash at a figure which seems satisfactory to the producer. The buyers in turn pack the fruit in large containers of various types and export it to the mainland. I have purchased these dates in Guadalajara, Mazatlan, Hermosillo and other mainland cities in the past and do not believe that any further processing takes place. Bunches of green dates are also hauled to non-producing areas of the Peninsula and maturated by the consumer.

Of course no thinning or other operation to increase size is attempted. No protection from the weather is necessary when the fruit is harvested so far ahead of maturity. I have never seen any dried fruit beetles in any district and have never observed any in dates purchased on the mainland. No fumigation of any sort takes place at the point of production and the shippers I have talked with indicated that there was no necessity for this protection.

Ripening takes place in these various locations at different times, depending apparently on which coast affects their weather. For instance, San Ignacio had about one-third of the fruit on the trees the middle of December. Its weather is influenced by the Pacific, while Mulege on the Gulf shore had completed harvest at that time.

Trees are producing along the Santa Rosalia River at Mulege, below the dam, where the salt water of the Gulf fills the stream bed, and along San Lucas Bay date trees are growing just above the high tide mark and seem to be doing well.

Fruit, trees, bunches and stems seem to be remarkably similar for an all-seedling planting, leading one to think that perhaps 230 years of natural cross-breeding, without the introduction of any new strains, has stabilized the type to some degree. However, in my opinion, such natural cross-breeding has resulted in degeneration, as I am sure the original introduction must have been of a better quality date.

All through the date growing areas, I met people who had eaten our dates, probably hydrated Deglets, and

they were positive that we boiled them in honey. My statement that they grew that way was accepted, but I do not think believed.

There is not much that could be done to improve the situation in Baja California as the entire present plantings would have to be removed, a satisfactory variety established, a supply of offshoots found and made available, and more modern methods of handling instituted. Land in these small watered arroyos has been handed down from Father to Son until the individual holdings average about 2½ acres, which is too small to support a family. Consequently, the young men have left and production is largely in the hands of old men and the women and children.

I do not believe that there is anything we can learn from Baja California that will aid us in producing better dates.

THE NITROGEN CONTENT OF SOME DATE GARDEN SOILS IN RELATION TO SOIL MANAGEMENT PRACTICES

By J. R. Furr and H. D. Barber[1]
U. S. Date Garden, Indio, California

The principal objective of the present investigation was to obtain information regarding the amounts of nitrogen and organic matter occurring in soils that have been cultivated to dates for some time as compared with that occurring naturally in similar virgin soils.

It is well known that desert soils in the virgin state are characteristically low in organic matter and total nitrogen. This is true in part because with low rainfall there is little growth of plants and consequently little accumulation of soil organic matter, in which is contained nearly all of the soil nitrogen. There is also a pronounced decrease in the nitrogen content of the soil with rise in mean annual temperature. This has been shown in a striking manner in Jenny's study of the influence of climate on nitrogen content of the soil (3). He showed that in a semi-arid belt extending from Canada to south Texas the nitrogen content of the soil diminished from about 0.3 per cent where the mean annual temperature is 32° F. to about 0.07 per cent where it is 72° F.

With an average annual rainfall of only 3 inches and a mean annual temperature of 73.4° F., the nitrogen content of virgin Coachella Valley soils can reasonably be expected to be low. Coachella Valley soils are, however, alluvial fills of very recent origin and may be expected to differ in some respects from residual soils formed under similar climatic conditions. When dates are grown on these soils, furthermore, radical changes are made in the moisture and temperature conditions of the soil, and in many gardens applications of manure or other bulky organic materials as well as of inorganic nitrogen fertilizers are made with more or less regularity. It was hoped that an investigation of the nitrogen and organic carbon content of soil samples taken from date gardens that had been under different soil management programs and from similar virgin soils would indicate the trend of changes that may have occurred in the cultivated soils under the different practices.

METHODS AND DESCRIPTION OF SAMPLING LOCATIONS

In collecting soil for analysis, five samples were taken to a depth of 8 feet at each of five stations, in both the date gardens and the virgin soil areas, except for several cases that will be noted later. At each station, the samples from the first two feet were composited at 1-foot intervals, and from the lower depths, at 2-foot intervals. The stations in the date gardens were about 30 feet apart and in a line parallel to the adjacent virgin land. The stations on the virgin land were paired with those in the date garden in each instance. Several locations of interest where adjacent virgin land was not available were also sampled.

Nitrogen was determined by the Kjeldahl method, without modification to include nitrates, and organic carbon was determined by the modified Walkley-Black Method (5). A mechanical analysis of each sample was made by the hydrometer method of Bouyoucos (1).

Information regarding the application of organic materials and inorganic nitrogen fertilizers applied to the date gardens sampled was obtained from the growers. Each location was assigned an identification symbol consisting of a letter and a number. Those assigned the same letter are adjacent areas of similar soil. The estimated amounts of organic matter and nitrogen applied

Table 1.—Estimated Amounts of Organic Matter, and of Nitrogen from Organic Matter and from Inorganic Fertilizer Applied to Date Gardens Sampled.

Location	Age of Garden (years)	Period	Organic Matter per acre		Nitrogen Applied per Acre		
			Manure (tons)	Prunings (tons)	As Organic Matter (lbs.)	As Inorganic Fertilizer (lbs.)	Total (lbs.)
A-1	25	1939-49	120	.....	4320	1440	5760
B-1	20	1939-49	79	.....	2844	672	3516
C-1	11	1939-41	.....	.....	.....	.....	.....
		1942-47	48.4	.....	1791	252	2043
		1947-49	.....	.....	.....	.....	.....
D-1	7	1942-45	.....	.....	.....	.....	.....
		1945-47	30	.....	1080	360	1440
		1947-49	.....	.....	.....	360	360
		1945-49	.....	.....	.....	.....	1800*
E-1	13	1939-43	.....	.....	.....	.....	.....
		1943-46	30	.....	1080	384	1464
		1946-49	.....	5.4	53	.....	53
		1939-49	.....	.....	.....	.....	1517*
E-2	6	1943-49	.....	.....	.....	.....	.....
F-1	6	1943-49	.....	.....	.....	.....	.....
G-1	30	1939-49	60	24.0	1430	.....	1430
H-1	17	1939-49	100	.....	2000	100	2100
J-1	19	1939-49	25	.....	750	3840	4590
K-1	39	1939-49	.....	.....	.....	.....	.....

*Sum of the two preceding amounts.

1. Senior Horticulturist and Scientific Aid, respectively, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

per acre during the 10 years prior to sampling, or for the life of the garden in the case of those less than 10 years of age, are shown in Table 1. In most of the gardens the applications of manure were above normal during the period 1943-1947 and were relatively light in 1948 and 1949. Leaf and fruitstalk prunings were applied to the soil in only two of the gardens. In one of these, E-1, the amount was small because the planting was relatively young when sampled; but in the other, G-1, which was 30 years old, prunings had been applied for the life of the garden and were estimated to amount to 24 tons in the ten years prior to sampling.

RESULTS

The range in nitrogen content of the samples from all locations was from about .003 per cent to about .120 per cent of the dry soil. In general, the highest percentages of nitrogen occurred in samples containing 50 per cent or more of silt plus clay, and from the upper one or two feet of soil; and the lowest in very sandy samples from the 4-8 foot zone. Some notion of the average nitrogen content of these soils in relation to depth below the surface and to texture may be obtained from an examination of Table 2. As might be expected, these average values show a general increase in nitrogen content with increasing percentage of silt plus clay, and a decrease from the surface foot to the 6-8 foot level. Statistical analysis of the data from five locations where the date gardens were fertilized and where five paired stations were sampled in virgin and cultivated soils indicate that in the top foot the nitrogen content of the cultivated soil averaged 1436 pounds per acre, while the top foot of the virgin soil averaged 996 pounds per acre, a difference which is significant by odds of more than 99:1.

The amounts of organic matter and nitrogen in pounds per acre-foot of soil and the average percentages of sand, silt, and clay were calculated for each depth interval at each location sampled; but because of the extent of these data only the total amounts of organic matter and nitrogen and the average percentages of sand, silt, and clay in the total depth sampled at each location are tabulated (Table 3). These calculations were based on an assumed weight of 4,000,000 pounds per acre-foot of dry soil. The percentages of organic matter in all locations except D-1 and D-2 were calculated by multiplying the percentages of carbon by the factor 1.724. Carbon determinations were not made on samples from locations D-1 and D-2, so the percentages of organic matter in these locations were calculated by multiplying the nitrogen percentages by the factor 20. In relation to the other locations, this gives slightly high values of organic matter.

Location A-1 was in a vigorous 25-year-old garden that had been heavily fertilized from the time it came into bearing. During the ten years prior to sampling it received an average per acre per year of 12 tons of manure and 144 pounds of inorganic nitrogen, or an estimated total of 5,760 lbs. of nitrogen in the 10 years (see table 1). The average proportions of sand, silt and clay in the 0-8 foot zone sampled were similar in the A-1 and A-2 locations, but varied appreciably at some levels. In spite of these obvious variations in texture the relatively small difference in the amount of nitrogen, 560 lbs., in the 0-8 foot zone of the two locations suggest that the heavy applications of organic matter and nitrogen had not resulted in large accumulations, though they doubtless maintained an ample supply of available nitrogen for the trees.

Though the trees on location B-1 were only 20 years old, this land had been in cultivation for some time before dates were planted. Moderate to heavy applications of manure were made during the 10 years prior to sampling, except in 1948-49, when none was applied. Location B-2 was covered by mesquite of moderate vigor. The owner thought that location B-1 was also covered by mesquite in the virgin state. The cultivated soil contained a slightly higher percentage of silt and clay than the virgin soil; but it is somewhat surprising to find that the amount of organic matter and nitrogen were on the average slightly higher in the cultivated than in the virgin soil, since soils covered by mesquite usually are considered to be exceptionally fertile.

Locations C-1 and C-2 were in an area that was apparently subject to

Table 2.—The Average Nitrogen Content of All Soil Samples in Relation to Depth and Texture.

Silt & Clay (%)	Percentage Nitrogen 0-1 (feet)	1-2 (feet)	2-4 (feet)	4-6 (feet)	6-8 (feet)
0-19.9	.024	.011	.010	.009	.007
20-39.9	.045	.033	.019	.013	.009
40-59.9	.066	.046	.027	.017	.015
60-79.9	.048	.040	.038	.051	.038
80-100	.055	.081	.059	.....	.....

Table 3.—The Calculated Amounts of Organic Matter and Nitrogen Per Acre, and the Percentages of Sand, Silt and Clay Found in Date Gardens and in Virgin Soils.

Sampling Location and Description	Depth Sampled (feet)	Organic Matter per Acre (lbs.)	Nitrogen per Acre (lbs.)	Sand (%)	Silt (%)	Clay (%)
A-1, Dates, age 25 yrs., cult.	0-8	78,000	5,280	59.5	30.6	10.0
A-2, Virgin soil, mixed shrubs	0-8	77,240	4,720	60.6	30.7	8.7
B-1, Dates, age 20 yrs., cult.	0-8	67,080	4,960	61.1	28.9	10.0
B-2, Virgin soil, mesquite	0-8	50,760	4,840	70.8	20.8	8.5
C-1, Dates, age 11 yrs., cult.	0-8	213,240	11,920	43.9	38.3	17.8
C-2, Virgin soil, mixed shrubs	0-8	227,960	13,600	46.1	41.7	12.3
D-1, Dates, age 7 yrs., cult.	0-8	44,000	2,200	78.6	16.8	4.6
D-2, Virgin soil, mixed shrubs	0-8	40,800	2,040	77.1	17.9	5.1
E-1, Dates, age 13 yrs., cult.	0-8	135,080	10,320	73.2	21.9	5.0
E-2, Dates, age 6 yrs., cult.	0-8	214,680	15,760	65.4	28.5	6.2
F-1, Dates, age 6 yrs., cult.	0-8	103,520	8,240	73.1	23.8	3.1
F-2, Virgin soil, mesquite	0-8	108,080	9,680	73.8	23.5	2.8
G-1, Dates, age 30 yrs., cult.	0-8	55,120	3,680	84.2	13.1	2.7
G-2, Virgin soil, mixed shrubs	0-8	41,320	2,760	87.2	11.1	1.8
H-1, Dates, age 17 yrs., cult.	0-4	35,520	2,920	69.6	27.4	3.1
H-2, Virgin soil, just leveled	0-4	10,440	1,040	78.1	20.1	2.0
H-3, Virgin soil, mixed shrubs	0-4	25,320	1,600	72.9	25.4	1.8
J-1, Dates, age 19 yrs., sod	0-8	98,160	6,320	63.8	27.2	9.1
K-1, Dates, age 39 yrs., cult.	0-8	111,840	6,920	60.4	28.6	11.1
K-2, Lawn, Bermuda sod	0-8	142,960	8,720	56.6	31.1	12.4

flooding by the White Water River in recent years. The dates were fertilized during the 5-year period 1942-47 with 48.4 tons of manure and a small amount of inorganic nitrogen, an estimated total of about 2,000 lbs. of nitrogen per acre. As might be expected of soils laid down by flood waters, the texture at the different levels in these two locations was variable, though the averages of sand, silt and clay in the 0-8 foot zones are similar. The large amounts of nitrogen found in the lower depths at these two locations, and especially in the virgin soil, suggest that considerable amounts of organic materials were incorporated in the soil when it was deposited and that the deposits were recent. If the difference in the amount of nitrogen at locations C-1 and C-2 means anything except that the soil is variable, then it would appear that some loss in nitrogen has occurred under cultivation. This seems somewhat plausible in view of the relatively light applications of manure made at this location.

The soil of locations D-1 and D-2 have a high percentage of sand, and the water used for irrigation was saline, though not extremely high in salt. The trees were planted in 1942 and no fertilizer was applied until the period 1945-47, during which 30 tons of manure per acre was applied. In the period 1947-49, 360 pounds of inorganic nitrogen per acre was applied. The estimated total nitrogen per acre applied during the 4-year period 1945-49 was 1,800 lbs. The average percentages of sand, silt and clay at the two locations are nearly the same, but it seems apparent that the small variations in amounts of silt and clay at the different levels had more influence upon the amount of nitrogen held in the soil than was true in the less sandy soils. The total nitrogen in the 0-8 foot zone of locations D-1 and D-2 were practically the same, and extremely low. One unusual practice at this location was to keep a trickle of water in some of the furrows so that some of the soil was above field capacity practically all of the time during the summer months. In experiments carried out with dates on a well irrigated but very sandy soil, Reuther (4) found that trees were benefited by applying a continuous spray of water to the soil. In spite of the low reserve of organic nitrogen at location D-1, and conditions that would seem favorable for excessive leaching, the trees apparently received an ample supply of readily available nitrogen from the heavy fertilization during the 4 years preceding sampling, for the trees had made vigorous growth, yields were fairly high, and the fruits were large, though of rather poor quality.

Locations E-1 and E-2 were both under cultivation; the former for 13 years, the latter for 6 years. Both locations in the virgin state were covered with a very heavy growth of mesquite. At each, the dates were planted when the land was cleared. The residue of organic material was extremely heavy when the soil was placed under cultivation. It was claimed that in some places the partially decayed organic material was several feet deep. The results obtained at these locations, it is believed, illustrate the changes that occur in soils of high organic matter and nitrogen content when they are brought under cultivation under Coachella Valley conditions. Although the silt and clay percentages of the soil at location E-2 were slightly higher than at E-1, and the organic matter and nitrogen contents were probably also slightly higher in the virgin condition, the large difference in amount of organic matter and nitrogen at the time of sampling suggests that the rate of loss of these substances in a 13-year period as compared to a 6-year period had resulted in the much lower amounts found in location E-1 than in E-2. It also appears that the amount of organic matter and nitrogen applied at location E-1 failed to compensate for the losses. That much readily decomposable, or "active," organic matter still remained in the unfertilized soil of E-2 was indicated by the extremely lush growth of pigweeds (*Amaranthus* spp.) at this location. Qualitative tests made on the stems and petioles of these plants, which accumulated nitrate under conditions of luxury consumption, indicated that they contained relatively large amounts of nitrate.

Locations F-1 and F-2 were on the same ranch as locations E-1 and 2, but were on the margin of the area originally covered by mesquite thickets. The uncleared land adjoining location F-1 was covered by mixed shrubs and small thickets of mesquite. Location F-2 was covered by mesquite, which, however, was less dense and vigorous than the mesquite that originally covered locations E-1 and E-2. The texture of soil was nearly the same at both locations so that the difference in organic matter and nitrogen found may represent fairly accurately the losses that had occurred during 6 years of cultivation of the soil at location F-1; but it seems apparent that the accumulation of organic matter and nitrogen in the soil of the area that was marginal for mesquite was very much less than in the area that had been especially favorable for the growth of this legume.

The soil of locations G-1 and G-2 contained a higher percentage of sand than any of the other locations sampled. Because of the high sand content the small differences in average percentage of silt and clay may have had an appreciable influence on the amounts of organic matter in the soil of the two locations. Even after 30 years of cultivation, however, the amounts of organic matter and nitrogen were higher in the cultivated than in the virgin soil. This situation is of considerable interest, because the applications per year of fertilizer at location G-1 consisted of 5-7 tons of manure per acre, and the leaf and fruitstalk prunings. The estimated total amount of nitrogen applied in the 10 years prior to sampling was only 1430 lbs. This fertilizer program was followed throughout the life of the garden and no inorganic nitrogen was ever applied. The trees (variety Deglet Noor) at this location have consistenly borne heavy crops (often 400 pounds per tree) of high quality fruit and are probably as tall as any date palms in the Coachella Valley. In the virgin soil of location G-2 the average percentages of nitrogen at the 0-1, 1-2, 2-4, and 4-8 levels were, respectively, .017, .012, .010 and .005. It is possible that at such a low level of nitrogen there actually was an increase in organic matter and nitrogen under cultivation; but, if so, the accumulation was not great, for the amounts of carbon and nitrogen found were very low.

The sampling at locations H-1, H-2, and H-3 was the first done and was exploratory in nature. Only two stations were sampled at locations H-1 and H-2 and one at H-3 and the samples were taken to a depth of only 4 feet so that the results are no more than suggestive. The soils at these locations were relatively sandy and low in nitrogen; as a consequence it is possible that the fairly heavy regular applications of manure at location H-1 has, as the data suggest, raised the nitrogen content of the cultivated soil. In spite of the apparently low nitrogen content of the soil at location H-1, the palms (variety Deglet Noor) have been exceptionally vigorous and productive and the fruit of high quality.

Unfortunately there was no virgin soil near location J-1 with which to compare it, but because of its unusual interest it was sampled. The garden in which J-1 was located was at first cultivated, but for about 10 years prior to sampling it was covered by a dense sod of Bermuda grass and was pastured to sheep. The applications of inorganic nitrogen were heavy and the sheep were fed some alfalfa hay. These conditions would seem to be ideal for large accumulations of organic matter and nitrogen in the soil. Probably there was an appreciable increase after cultivation was stopped, but the amounts of organic matter and nitrogen do not seem exceptionally large in comparison with some of the other locations of about the same texture. This illustrates the difficulty of bringing about

very large accumulations of organic matter and nitrogen under Coachella Valley climatic conditions.

The amounts of organic matter and nitrogen found in locations K-1 and K-2 provide a comparison of the effect of long-continued cultivation with very small additions of organic matter and nitrogen, as compared to permanent sod with small additions of inorganic nitrogen fertilizer per year. The dates on location K-1 were planted in 1910 and for 10 years or more prior to sampling had been maintained without fertilization, though during the period 1923-34 a total of about 50 tons of manure per acre was applied. Location K-2 was in a lawn that had been in Bermuda grass for 15 years or more and had probably received about 50 lbs. of nitrogen per acre per year from inorganic fertilizers, amounting in the 10-year period to a total of about 500 pounds of nitrogen. The soil of location K-2 contained a slightly higher proportion of silt and clay than K-1, and may have had a higher content of organic matter and nitrogen than K-1 when this soil was in the virgin state. The rather large and consistent difference in organic matter and nitrogen at all levels, except the 6-8 foot zone which was in each location about 90 per cent sand, indicates that such difference was due largely to the difference in the environmental conditions of the two locations. There was probably some accumulation of organic matter and nitrogen in the soil of location K-2 during the 15 years in sod, and there were probably appreciable losses during this time in the unfertilized cultivated soil.

In considering the amounts of nitrogen applied to dates and the probable losses from the soil, it would be of interest to know how much nitrogen is taken up by the palms. Little information is available on the nitrogen requirement of the date, but an estimate, based largely upon the analyses of Embleton and Cook (2), was made of the amount of nitrogen removed each year by an acre (48 trees) of Deglet Noor dates in full bearing. Although no data were available, the percentage of nitrogen in trunk and roots was assumed to be about the same as that of the leaf rachis (0.2 per cent). The weight of new roots in excess of those decomposing was assumed to be 10 per cent of the weight of new trunk. This estimate, given in table 4, indicates that about 69 pounds of nitrogen per acre per year is removed from the soil or tied up in the plant. Some of this nitrogen would be returned to the soil as dropped fruit and as prunings not removed from the garden.

Table 4. — The Estimated Amount of Nitrogen Removed Per Year from the Soil by an Acre (48 trees) of Deglet Noor Dates in Full Bearing.

	Dry Wt. per acre (lbs.)	Nitrogen (%)	Nitrogen per acre (lbs.)
Leaves	3,760	0.49	19.0
Fruitstalks	1,050	0.30	3.7
Fruit	9,240	0.41	38.0
Trunk	3,744	0.20	7.5
Roots	375	0.20	0.75
Total			68.95

DISCUSSION AND CONCLUSIONS

A comparison of the nitrogen content of virgin soil with that of the similar locations in date gardens shows that in a majority of the cases the nitrogen content was higher, especially in the top foot, in the cultivated, fertilized soils than in the virgin soils. The data indicate that in general the relatively low levels of organic matter and nitrogen found in most of these soils in the virgin state are at least being maintained under cultivation. The top soil apparently increased in nitrogen content in most cases, but this was offset in part by a decrease at the lower depths.

It appears that most of the carbon and nitrogen from very heavy applications of manure and inorganic nitrogen, such as those made at location A-1, has been lost from the soil. The levels of available nitrogen (ammonia and nitrate) must, of course, have been much higher in these soils than would have been the case if much smaller amounts of nitrogenous materials had been applied.

That the maintenance of an extremely high level of readily available nitrogen in the soil is necessary for adequate absorption by the date palm seems doubtful. Since there has been little experimental evidence available regarding the response of dates to nitrogen fertilization, it is likely that fertilizer practice in date growing has been considerably influenced by that in citrus culture in Southern California, where it has generally been found necessary to apply 200 to 300 pounds of nitrogen per acre to obtain maximum yields. This exceeds the use of nitrogen considered to be economical on most tree fruits in most regions, so that annual applications of more than 200 to 300 pounds per acre to dates should probably be considered of questionable economy until evidence to the contrary is obtained.

Many annual plants, which have most of the root system in the top foot or two of soil, require high concentrations of nutrients during a limited period when most of the growth is made. It is unlikely that there is any such short critical period for the absorption of mineral nutrients by date palms, because growth is continuous throughout the year, though the rate varies with the seasons, and the root system extends to such great depths that some roots are probably always in soil where temperature and other conditions are favorable for absorption. Another factor that may be of importance is the large carbohydrate reserve of the date which probably provides a source of energy for absorption of mineral nutrients by the roots at practically all times. It would seem that these characteristics might enable the date palm to absorb adequate amounts of nitrogen at relatively low levels of available nitrogen, and that this is indeed so is indicated by the large yields obtained at several of the locations where only moderate amounts of nitrogen were applied to soils that were low in nitrogen.

Soil scientists have found that the nitrogen content of organic matter incorporated in the soil has a profound influence upon the rate of decay and humus formation. They have repeatedly shown that to obtain fairly rapid decomposition, and to avoid temporary depletion of nitrate nitrogen in the soil during the process of humus formation, organic material added to the soil should contain about 1.5 per cent or more of nitrogen. Thus, it would seem to be desirable to apply some inorganic nitrogen following the incorporation of date prunings with the soil, for this material contains only about 0.5 per cent nitrogen.

While it is apparent that heavy fertilization with organic and inorganic nitrogenous materials has brought about a significant increase in the nitrogen content of the top foot of soil in the date gardens it seems that the increase in the nitrogen reserves of the top 8 feet as a whole have not increased in proportion to the amounts applied.

It has been shown in a number of investigations that under a given set of environmental conditions the organic matter and total nitrogen content of a soil have a characteristic equilibrium level, and that it is not economically feasible to maintain a higher level by increasing the applications of organic materials and nitrogen because the losses increase in nearly the same proportion as the additions.

SUMMARY

Soil samples taken at intervals of 1 or 2 feet to a depth of 8 feet from several date gardens and from adjoining virgin soils were analyzed for organic nitrogen, organic carbon, and particle size.

The results indicate that the differences in amounts of nitrogen and carbon in the top foot and in the lower depths are not so pronounced as in humid region soils, though a gradual decrease in nitrogen and

carbon was found with increasing depth, and with increasing percentage of sand in the samples. The percentages of nitrogen and carbon were significantly higher in the top foot of soil from fertilized date gardens than in the top foot of adjacent virgin soils. The average amounts of nitrogen and of carbon in the top 8 feet of soil in date gardens were, however, not greatly different from those in comparable virgin soils.

The results show that while the percentages of nitrogen in these soils is low (less than 0.1 per cent), the total nitrogen reserves of the top 8 feet varied from about 2,000 to about 15,000 pounds of nitrogen per acre.

It was estimated that an acre of dates in full bearing removes from the soil about 69 pounds of nitrogen per acre per year, though some of this may be returned to the soil by dropped fruit, leaves, etc.

It seems apparent that a large part of the nitrogen and carbon from heavy applications of manure and other nitrogen fertilizers was lost from the date garden soils and that there was little increase in the humus except in the upper foot of soil.

LITERATURE CITED

1. *Bouyoucos, G. J. Directions for making mechanical anlyses of soils by the hydrometer method. Soil Sci. 42:225-229. 1936.*
2. *Embleton, T. W., and J. A. Cook. Fertilizer value of date leaf and fruitstalk prunings. Date Growers' Inst. Rept. 24:18-19. 1947.*
3. *Jenny, H. A study of the influence of climate upon the nitrogen and organic matter content of the soil. Missouri Agr. Expt. Sta. Res. Bul. 152. 1930.*
4. *Reuther, W. Response of Deglet Noor date palms to irrigation on a deep sandy soil. Date Growers' Inst. Rept. 21:16-19.* 1944.
5. *Walkley, A. A critical examination of a rapid method for determining organic carbon in soils—effect of variations in digestion conditions and of inorganic soil constituents. Soil Sci. 63:251-264. 1947.*

MARKETING FRUITS UNDER AGREEMENTS & ORDERS

R. C. Rock

Extension Specialist in Agricultural Economics

Present State and Federal laws authorizing fruit growers to regulate industry sales of their product are the result of many years' experience in this field. Soon after the beginning of specialty crop production in California, in the late 1800s, certain marketing problems became apparent and pointed to a need for some type of cooperative marketing program. During the early days interest was centered in cooperative fruit marketing associations as a solution to these problems. Voluntary marketing agreements were also tried but with few exceptions these voluntary programs fell short of effectively providing for orderly marketing. In voluntary programs it was found participants in such a program ceased to participate when rising prices made it temporarily more profitable for them to get out, and that non-participants benefited but did not share the burden.

By 1933, this situation was recognized and Federal legislation was passed providing that the small minority of growers in an industry could be required by law to participate in programs which have been approved by the large majority of growers and handlers. Similar State legislation followed providing authority to regulate sales in intra-state commerce. At the present time California fruit growers may carry out a marketing control program under the authority of the Federal Agricultural Marketing Act of 1937 and under 3 State acts, namely the California Marketing Act of 1937, the California Agricultural Products Marketing Act, and the California Agricultural Producers Marketing Act. Last year in California there were 16 fruit programs under authority of State legislation and 9 fruit programs under Federal law. These marketing control programs for fruit included apples, figs, grapes, raisins, wine, peaches, pears, plums, prunes, grapefruit, oranges, lemons, olives, and dates.

The economic basis for giving fruit growers the legal sanction to regulate sales is found in the unique problems which face them in marketing their products. The Marketing of California fruits is a complex and risky business. Many fruits are shipped great distances and marketing costs are both high and rigid. Grower prices are subject to unusually wide price swings as supplies and business conditions vary in distant markets. In many cases, a small decline in retail prices has been associated with a precipitous decline in grower net returns. For this reason individual growers have an interest in the orderly balancing of industry supply and demand in order to prevent such extreme price breaks and to stabilize their net returns.

This orderly balancing of industry supply and demand is not necessarily automatic when growers act alone in the marketing of their product. Industry supply or production cannot be controlled by anyone. Changes in supply from year to year are mainly due to fluctuations in yield. Weather partly determines yield per acre and cannot be controlled. Changes in demand are also beyond the control of individual growers. Some non-farm firms are big enough to hold prices in the face of declining purchasing power. These non-farm firms can actually cut down cost by curtailing output. Their plants may be shut down without damage. None of these adjustments are usually feasible in fruit production. The adjustment of volume sold is practically the only way that an industry's cash receipts may be stabilized fast enough to do much good in surplus years.

The job facing an industry of adjusting sales so that changing supplies and demand may be in balance to maximize return to growers is a complex one. Most fruit crops can be sold in variable proportions between different outlets, such as fresh, dried, canned, frozen or otherwise processed. Also, they are distributed in varying quantity to different geographical markets by different varieties and grades. In order to maximize net returns to growers, sales must be adjusted in the various channels. By working together and by adjusting relative sales in various channels, an industry has the best opportunity of allocating sales and maximizing return to growers.

Market control programs are not a cure-all for the ills of an industry and, if unwisely used, are dangerous to all concerned, especially the growers. They are, at times, difficult to administer and the problem of distributing equally the benefits and burdens among participants of a program is a difficult one. They cannot be used for production control. In an overexpanded industry the limitation of sales should not be used to prevent the necessary shrinking of acreage. There is also danger in restricting sales and raising prices to a point where consumers are driven to the purchase of other substitute goods. Such monopolistic use of control also tends to bring about an unwarranted expansion within the industry.

Generally, marketing programs begin when a group of growers of a

given crop fearing that their crop will bring unduly low returns appeal to the proper authorities and ask that a control program be instituted for their industry. If there is an economic justification for the establishment of a program and there is reasonable possibility of different elements in the industry working together, a public hearing is held. At such hearings economic data are supplied by various handlers, growers, government representatives and any other person. It must be shown that the proposed program tends to effectuate the declared policy of the act under which the program is being effectuated. The declared policy of Federal legislation is that incomes of growers will be raised and stabilized, consumers will be protected, and minimum standards of maturity, quality, grading and inspection will be maintained.

To become effective a proposed marketing agreement and order requires the consent of a substantial proportion of the producers concerned. In the case of Federal legislation, at least two-thirds of the number of producers in the proposed area (three-fourths in the case of California's citrus) or producers supplying two-thirds of the volume must favor a program. If the program affects handlers, approval on a parallel agreement is necessary from at least 50 per cent of the voting handlers. The program may be made effective over the handlers' dissent, if the Secretary finds that there is no other practical means except through the use of the program to carry out the declared policies of the act, and providing the program has been approved by two-thirds of the producers by number or volume. Agreements and orders under *State* law are made effective under similar provisions and approval by the industry. They may be terminated by the Secretary or Director of Agriculture if they cease to contribute to the goals of the act or upon petition of a majority of producers.

Marketing agreements and orders operate on the principal of self regulation. Common to most agreements is the setting up of administrative committees composed of growers and handlers or both. Members are nominated by growers and handlers in the industry and approved by the Secretary or Director of Agriculture. The main function of these committees is to recommend specific regulations to the Secretary or Director of Agriculture. If these regulations tend to effectuate the declared policy of the act, an appropriate order is issued by the Secretary or Director. It should be remembered that the marketing agreement and order merely specifies the type and general scope of the regulation and the specific regulations covering any particular period of time are recommended by the administrative committee.

Several main types of industry control are authorized under existing legislation. Marketing agreements and orders may (1) limit sales in total or by grade, size, or quality in any market or time period, (2) allot purchases or sales among handlers, (3) measure, equalize, and dispose of surpluses, (4) establish reserve pools, (5) require inspection for quality, maturity, or size, and (6) provide for the prohibition of unfair trade practices and for open price filing. Under *State* law provisions are also made for an industry to carry on trade promotion and advertising.

Marketing agreements and orders are industry financed programs. Usually the administrative committee of the program makes out a budget each year and, after approval by the Secretary or Director, handlers are assessed accordingly. The assessments are usually in terms of so much per box, bag, or other unit shipped during the season. Any excess is paid back on a pro-rata basis.

The enforcement of marketing agreements and orders primarily rests with the government but administrative committees are charged with the duty of investigating and reporting complaints of violations. Enforcement may be made through civil suits for damage, civil injunctions, and most often through fines after criminal conviction.

In summary, experience has shown that by acting together in marketing growers of many specialty products can protect themselves against unusually wide swings in net return associated with changes in yield and business conditions. Central regulation has the possibility of increasing returns by assuring the best possible distribution among different markets, by preventing floods in major channels, and by preventing damage to other markets through overshipment by grade, or size, or in total quantity, and by keeping poor quality and pack off the market. The Federal Agricultural Marketing Agreement Act and 3 State marketing agreement acts make it possible to limit or to regulate industry sales through programs initiated, formulated, and administered by growers and handlers themselves. Final authority for these programs rests with the Secretary of Agriculture or the State Director of Agriculture but programs are directly administered by industry committees nominated by the industry. Any action taken by the Secretary or Director of Agriculture must be consistent with the declared policies of the acts, and programs may be terminated on petition of a majority of producers. Marketing agreement and order legislation authorize broad powers for the regulation of volume, grade or size, maturity, pack, rate of flow, surplus diversion, reserve or substandard pools, price posting, and prohibition of unfair practices or methods. Under *State* legislation trade promotion and industry advertising are also allowed. Marketing agreements and orders are not a cure-all for the ills of an industry. Badly used, the limitation of sales is dangerous to all groups and especially to the growers. In an over-expanded industry limitation of sales should not be attempted to prevent the necessary shrinking of over-expanded acreage. There is also danger in restricting sales to the point where prices are raised, driving consumers to other goods and inducing expanded acreage within the industry. On the other hand, an industry with a marketing program administered by competent men who recognize the potential dangers, as well as the benefits, can do much to raise or stabilize net returns to their growers.

OPERATIONS OF MARKETING ORDERS WITH PARTICULAR REFERENCE TO THE MARKETING ORDER FOR DATES

J. F. Bennett
Bureau of Markets, State Department of Agriculture

Marketing agreements and marketing orders have become increasingly important in agriculture during the past few years. This applies to American agriculture in general and to California agriculture probably to a greater extent than to the agriculture of any other State. As an example this increase in importance has been evidenced by the inclusion of marketing control programs in the national agricultural programs now under consideration. The Brannan plan as well as other agricultural plans under consideration include reference to, or make specific use of, marketing agreements and marketing orders.

There are currently operative in California 26 marketing control programs established under State authority and in addition 6 industries are at various stages of progress in the development of such plans. With the increased activities involving these devices it might be well to review their background to determine to what extent the duties and obligation of an industry which has undertaken the operation of a marketing order are transferred to the government.

The historical development of marketing orders would properly include a review of the complete agricultural development to its present status. However, the items which bear most directly on marketing orders as they are today in effect probably have occurred to a great extent during the past few decades. American farmers as well as other American business men are probably not by nature inclined to work together in conducting their business. Our economy was developed primarily through competition of individuals. However, the economic and natural hazards which confront that section of our agriculture dealing with fruits and vegetables present some problems which led to the overcoming of our inherent desire to operate as individuals. This need for cooperative activity was recognized by producers long before there was any law authorizing such cooperative activities. Farmers first began cooperating in marketing in order to survive economically. In the late 1800's they learned that through cooperation they could obtain better services in the marketing of their commodity, could obtain better information relating to this marketing, could to a greater degree influence consumers of their product and provide greater services than could the individual farmers operating independently.

Soon groups of farmers began selling their output as a single unit. As this work increased the cooperatives attempted to effectuate limitations and regulations of marketing practices. These efforts met with nearly uniform failure, primarily because if the attempts were initially successful in improving prices, the members of the group sought an opportunity to withdraw from the cooperative and to benefit from the effect of the regulation without contributing to the burden of the regulation. Likewise, outsiders gained more than the original members of the cooperatives since they received all of the benefits without sharing any of the burden.

By profiting from some of the procedural mistakes made in the various cooperative attempts at controlled marketing, improvements were made in the methods followed. Complex contracts and agreements were developed. Administrative or advisory committees were established to determine policy matters. Cooperation with receiving and sales agencies was developed. Negotiations with transportation agencies led to uniform provisions covering all shipments of the commodity. Market news service was developed and perfected. Through these efforts two main lessons were learned; first that properly applied and administered, and supported by members, limitations and regulations can help agricultural industries, and second, voluntary agreements will generally fail because the members who are participating will see outsiders gaining the full benefits without sharing in the burden and will withdraw from membership.

The cooperatives were forced to turn to industry-wide limitation or regulation because no cooperative can regulate markets to which nonmembers of the cooperative have free access. The lessons learned led to the passage of State and Federal legislation using the powers of governmental agencies to enforce compliance with a marketing control program once a majority of the persons affected voted to accept the control devised in the main by themselves, out of their knowledge of the history and problems peculiar to their industry.

In the California Marketing Act of 1937, which is the primary law in the state of California under which marketing control programs are operative, is found a declaration of the State's policy with respect to its position in marketing control programs. The declared policy in this Act is "to aid agricultural producers in preventing economic waste in the marketing of their agricultural commodities, to develop more efficient and equitable methods in the marketing of agricultural commodities and to aid agricultural producers in restoring and maintaining their purchasing power at a more adequate, equitable and reasonable level." It should be emphasized that the Act says that it is the policy of the State to aid the *industry* in the development of marketing control programs and not for the *State* to develop these programs with the aid of the industry. In the enactment of this legislation as well as Federal legislation the intent was for the agricultural industries to develop and operate the programs with such aid as was required from the government in preventing the occurrence of those forces which caused the failure of early day cooperative marketing ventures. Through this aid the industry could be given assurance that the provisions of marketing control programs would fall equally upon all parties concerned.

The date industry first initiated a marketing control program under State legislation in 1938. It has operated this program continuously to the present except for the period of the war years. Because of the long association of the industry with marketing control programs it should be well recognized within this industry that the activities and operations conducted under a control program are initiated by and determined by the industry, within the legal bounds of the Marketing Act. The success or failure of a program rests with the industry and with their ability to devise and operate a program designed to meet the problems of the industry.

The adoption of a control program does not automatically solve an industry's problems. Neither does it transfer the duties and responsibilities of the industry to the government.

There are some shifts of responsibility from the individuals within the industry to the industry as a group. The government does assume an obligation to lend assistance. Basically, however, there has been no change in the fact that general conditions in our economic system and the policies and practices adopted by the industry will largely determine the degree of success achieved by an industry.

The date growers and the date packers, from their knowledge of the date industry, will have to determine whether or not they will operate a control program in the coming season. They will have to decide whether or not grade control, size control, inspection, trade promotion, advertising, market development will be of help to them.

Their decisions will be a selection of the tool they want to use in their responsibility of successfully producing and marketing their crop.

SYMPOSIUM ON 1949-50 FROST DAMAGE TO DATE PALMS

Leonhardt Swingle
Date Grower

It was the intention of the Date Institute to complete the report on the 1949 freeze this year but we have had another cold year with continued and additional damage and a final report must wait till the cold weather is finally past and the palms have recovered.

We have had a very cold winter with some gardens being more severely injured than last year and young plantings being generally more damaged than adjoining old palms. The cold was again quite spotted but as a rule the coldest gardens last year were again the coldest this season. It appears that in many cases there were cold drafts from the mountains and the cold seems to have stayed on the ground more closely so that young plantings were hurt much worse than a year ago.

An important point for date growers to learn is how cold it must be before the palms are injured. General observations at the Government Date Garden indicated that when the temperature gets below 24° F. leaf damage can be expected. When the temperature falls to 20° F. severe damage can be expected with the damage increasing every hour the temperature remains below 20. The attached table shows the temperatures at three stations in the Valley for 1949 and 1950. We can see from this that at the Government Date Garden there were four nights with temperatures below 24° F. in 1950 compared with two nights in 1949. Each year shows a total of two hours below 20° F. The years were near enough alike so that local variations in the Valley make 1949 colder in some gardens and 1950 colder in other gardens.

The most practical and available protection for the date grower when the temperature begins to get low enough to be dangerous is to turn on the water and keep the date garden wet. Frost injury to the date garden is not in loss of fruit on the palm, but in a freezing and loss of leaves so that the palm cannot support and mature the fruit crop the following year. It has never been cold enough to injure the fruit buds of the current year, but we found in 1937 that although the palms had a very good bloom, the loss of leaves prevented the proper development of the fruit. Frost protection on dates is to keep the leaves from injury. A date garden just irrigated or being irrigated when the temperature gets down to 20° F. has that much more heat stored as a protection and every date grower has this means of frost protection very close at hand.

The quality of the crop harvested in 1949 was much better on the whole than anticipated. While a favorable fall with a long growing season had a large part to do with the prompt recovery of the palms, two lessons were learned in 1937 that paid off this year. These were, first, cut back your crop if the palms are injured and second, leave the injured leaves on as long as possible. There is much evidence that there must be at least eight or nine leaves to a bunch. As long as the damaged leaves have green tissue, they give some benefit to the palm. The leaf and bunch management was much better this year than in 1937 and contributed to the development of the past crop.

MR. ROY W. NIXON[1], *U.S. Date Garden, Indio, California*: The critical temperature at which definite damage to date palms may be expected is about 20° F. While there may be some injury to date leaves when temperatures slightly above 20° F. are sufficiently prolonged, it is seldom enough to attract attention. This has been borne out by numerous observations, especially following the freeze of January, 1937, the most serious one that has occurred since the establishment of the date industry.

1. Division of Fruit & Vegetable Crops & Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

In the 42 years since records were begun at the U. S. Date Garden there have been only 6 winters when the minimum temperature was 20° F. or below. The temperatures and the dates on which they occurred are as follows:

17° F.—Dec. 27 and 29, 1911
15° F.—Jan. 7 and 8, 1913
18° F.—Jan. 2, 1919
13° F.—Jan. 22, 1937
20° F.—Jan. 5, 1949
18° F.—Jan. 4, 1950

In spite of the infrequency of such low temperatures, it is surprising to find that once before there have been two very cold winters in succession (1911-12 and 1912-13) when the temperatures were even lower than during the past two.

Although the Coachella Valley is relatively small, there is a considerable range in temperature within it. The U. S. Date Garden seems to represent a location that is about average. When the minimum temperature there is 20° F., at a few other localities the minimum may be 2 to 5 degrees lower and damage to date palms correspondingly greater. In addition to the freezes listed above there were 12 winters during 42 years when the minimum temperature at the U. S. Date Garden was between 20° and 24° and when some damage to date palms might have occurred in the coldest parts of Coachella Valley.

During the last two months a survey has been made of damage to

Duration of Low Temperatures on Dates When Minima of 20° F. or Below Were Recorded in Coachella Valley During January Freezes of 1949 & 1950*

	Minimum	Hrs. 24° & lower	Hrs. 20° & lower
Jan. 3-4, 1949			
U. S. Date Garden	20.0	11:00	1:00
64-B, Thermal-Vevers	18.8	4:50	0:40
60-B, Oasis-Ramsey	22.0	2:30	.....
Jan. 4-5, 1949			
U. S. Date Garden	20.0	11:00	1:00
64-B, Thermal-Vevers	16.7	9:00	3:00
60-B, Oasis-Ramsey	16.0	6:50	2:20
Jan. 3-4, 1950			
U. S. Date Garden	18.0	6:30	2:00
64-B, Thermal-Vevers	20.0	5:10	0:40
60-B, Oasis-Ramsey	20.0	2:10	0:20
Jan. 4-5, 1950			
U. S. Date Garden	23.0	1:00	.....
64-B, Thermal-Vevers	20.3	3:30	0:20
60-B, Oasis-Ramsey	23.0	0:50	.....
Jan. 5-6, 1950			
U. S. Date Garden	21.0	6:30	.....
64-B, Thermal-Vevers	20.6	2:30	.....
60-B, Oasis-Ramsey	19.5	2:00	0:20
Jan. 6-7, 1950			
U. S. Date Garden	19.5	no record	
64-B, Thermal-Vevers	20.8	5:30	.....
60-B, Oasis-Ramsey	20.0	4:50	0:40

*From U. S. Weather Bureau Reports. Location of stations: U. S. Date Garden, 1½ miles west of Indio; 64-B, Thermal-Vevers, ½ mile south and ¼ mile west of Valerie Jean Date Shop; 60-B, Oasis-Ramsey, ½ mile east of Oasis store.

date palms in various parts of Coachella Valley in order to study the problems arising from frost damage and to obtain information as to the relative cold resistance of date varieties. In the absence of detailed observations last year it has been possible to record only the cumulative damage of the two freezes. Observations have been complicated by the fact some damaged leaves were removed last year and some growers regularly prune higher than others. A palm pruned high enough to remove badly damaged leaves will look better than one on which they have been retained, but it may not have as much green leaf area. In estimating leaf damage on palms I have tried to compare leaves of the same age, of which an approximate idea can be had from the position on the trunk in relation to the fruit-stalks. Estimates have been made on the assumption that, for a normal crop, a Deglet Noor palm in full production would require a minimum of at least four years' growth, or not less than 100 leaves.

Damage to date palms varied greatly in all parts of Coachella Valley and in many instances even in the same garden. Usually the younger or the more exposed palms suffered the greatest injury, but sometimes there were differences without apparent cause.

In two districts more damage was observed than at the U. S. Date Garden: Indian Wells, from beyond Point Happy to near Rancho Mirage, and the High School District, in what might be called the floor of the Valley, from Avenue 56 to Avenue 66. Some gardens along the storm-water ditch below Thermal are included in the second district.

At the U.S. Date Garden Deglet Noor palms, 15 years of age and varying from 18 to 25 feet in height, were damaged to the extent of an estimated 25 percent reduction in leaf area. In some gardens in the two districts mentioned, Deglet Noor palms up to 5 ft. bud height lost from 75 to 100 percent of their leaf area and older palms from 25 to 50 percent, according to exposure and density of planting. In most of the Indio Heights district west to Point Happy and for about two miles south, on the east side of the valley, and in the Oasis district, the damage was less than at the U. S. Date Garden, amounting to a reduction of only 10 to 20 percent in leaf area.

Estimates of damage to date palms are based on the apparent amount of dead leaf tissue. At best this is rather crude because the damage to a date leaf does not affect the tissue uniformly throughout. Dead areas may be as small as a pinhead and surrounded by tissue apparently normal. Also there may be equally small chlorotic areas which apparently have been produced by low temperatures but where the amount of injury is questionable. Furthermore, different varieties are affected in different ways. In the Deglet Noor variety a large proportion of the dead tissue occurs at the tips of the pinnae, where it is quite conspicuous. In varieties like Halawy and Khadrawy an equal or greater proportion of dead tissue may occur in narrow interveinal streaks of varying length while the broader and stiffer tips of the pinnae remain green, so that the damage is less obvious from a casual inspection from a distance. Differences in character of foliage also complicate inspection. The Deglet Noor palm grows taller than the Khadrawy, and its leaves are less curved and usually more numerous. Hence, when examining a Deglet Noor palm one will look up at a higher angle and will see the conspicuous older leaves which show the greatest amount of damage. Because a Khadrawy palm is observed at a lower angle the younger and least damaged leaves are most conspicuous: as a consquence of this the damage may appear less than it really is. For the first 3 or 4 years after planting, however, there was little apparent difference between varieties as to cold damage.

I have attempted to group the principal varieties of dates as to cold resistance on the basis of apparent damage as recently observed. Most of them are not grown widely enough to afford opportunities for observation that are entirely satisfactory; but usually it has been possible to find one or more instanees where sueh varieties are growing with one of the better known varieties under similar conditions, and they have been evaluated accordingly. A possible source of error in drawing eonclusions in this way is the well-known fact that different varities do not grow equally well in the same environment. Deglet Noor, which is the variety most often compared with other varieties, has a rather narrow range of adaptation. It is quite possible that it might be in a poor condition of growth under certain conditions where some other variety would thrive. Since a plant, in a weakened condition for any reason whatever, is likely to be more damaged by cold than if it were in a thrifty condition, the relative damage to two varieties under the same conditions might not be comparable to that which would occur when each grows under the conditions that suit it best. The value of such observations, however, is cumulative and even though further evidence may cause ehanges in the ratings it seems desirable to record them.

In the following tabulation date varieties observed in the spring of 1950 in the Salt and Gila River valleys of Arizona as well as in the Coachella Valley of California have been compared as to damage—(1) less than average, (2) intermediate, and (3) more than average. More gradations might have been attempted, for obviously the varieties within any of these three groups were not always equally damaged, but only a few varieties are grown widely enough to provide adequate data. However, a few comments are in order about some of the commercial varieties. Again, as in 1937, Zahidi has been outstanding for its cold resistance, and is easily at the top of the list of all varieties that have been observed. Deglet Noor and Dayri appear to have sustained more damage than they did in 1937. Perhaps the cumulative effect of two suecesive freezes on some varieties are different from those on others; or there may be certain cyclic conditions of growth that vary between varieties at certain times and these may account for differences in susceptibility to damage from low temperatures. In relation to other varieties Khadrawy, Saidy, Barhee, and Maktoom appeared to have been damaged somewhat less than in 1937. Halawy and Khadrawy were given equal ratings after the 1937 freeze, but this time it was apparent in several gardens that Halawy was damaged more than Khadrawy. The most severe damage observed was on Rhars, Khalasa, and Braim, which agrees with observations following the 1937 freeze.

DATE VARIETIES COMPARED AS TO DAMAGE FROM THE JANUARY FREEZES OF 1949 AND 1950

Ammary—2
Amri—2
Apdandon—2
Areshty—2
Ashrasi—1
Barhee—2
Baydh Hammam—2
Bentamoda—1
Bent Keballa—1
Besser Haloo—1
Braim—3
Dayri—2
Deglet Noor—2
Dubayni—2
Fursi—3
Gantar—2
"Gush"—3
Hayany—1
Halawy—3
Hilali—3
Horra—2
Iteema—1
Jauzi—1
Kalara—3
Khadrawy—2
Khalasa—3
Khir—3
Koroch—1
Kush Batash—2
Kush Zebda—3
Kustawy—1
Maktoom—2
Medjool—2
Menakher—2
Mesh Degla—1
Rhars—3
Saidy—2
Sayer—1
Tadala—1
Tazizoot—1
Thoory—1
Zahidi—1
"16-23"—3

MR. R. H. HILGEMAN: On the nights of January 3-4, 4-5, 5-6, and 6-7, we recorded minimum temperatures of 18° F., 16.2°., 18° F., and 23° F. at the Arizona station. The second night was our coldest. We

had five hours below 20° F. and twelve hours below 25° F. on the night of January 4-5. Freeze conditions were similar to those of 1937, and our station was about average for the area. It was difficult to compare gardens as they are growing different varieties. Zahidi seemed to be least damaged, with Maktoom being most severely damaged. Hayany, Halawi, and Khadrawy fell between Zahidi and Maktoom in their relative degrees of injury.

R. S. DILLMAN, *Bard, California*: There was no frost damage in the Bard area. The minimum temperature for this past winter was 24° F.

MR. D. H. MITCHELL, *Indio*: I had a good chance to see frost damage, for the unofficial temperature in my date garden at Indian Wells reached a low of 8° F. Three year old palms were frozen to the bud. I believe they have been set back at least two years. A small number of palms seemed to be killed outright. Apparently young palms have more frost tolerance than we give them credit for.

MR. R. W. NIXON: The question has been asked if newly-planted offshoots or young palms can be protected from low temperatures by wraps. The answer is that a considerable degree of protection will be afforded by wrapping the young palms at time of planting with burlap, date leaves, cornstalks, or some such material. This not only protects against cold the following winter but also against sunburn the first summer. Some such protection for new plantings is practiced in the principal date-growing countries of the Old World. It was formerly done here, but in recent years has been largely abandoned. Of course, these low temperatures do not occur very often, but when they do occur, as just recently and back in 1937, I have repeatedly seen the value of such protection demonstrated in a reduction of injury. Mr. Hilgeman stated that he had not lost any of the young trees that he had wrapped. It is good insurance and not very expensive.

MR. L. SWINGLE: We may summarize our experiences and observations based on three freezes and make the following recommendations to date growers. First, when cold weather threatens see that the garden is well irrigated and turn the water on during a dangerous time when the temperature is expected to go as low as 20° F.

Second, if the palms have been frozen, cut back the crop to one bunche per eight or nine leaves, and do not leave too large a bunch.

Third, keep the leaves on the palms as long as possible even though they are badly frozen, for even a little green leaf area is a help to the palm in carrying the fruit to proper maturity.

Date Growers' Institute--1950 Membership

Anderson, L. J. . . . . Coachella
Arkell, Mrs. James . . . . . Indio

Bliss, Donald E. . . . . Riverside
Brown, T. R. . . . . Thermal

Caffey, W. A. . . . . Thermal
California Date Growers Association . Indio
Capper, Melvin . . . . . Palm Springs
Carlson, Ted . . . . . Indio
Cavanagh, H. L. . . . . Indio
Citrus Experiment Station . . . . Riverside
Clancy, Leslie M. . . . . Santa Monica
Clum, W. B. . . . . Los Angeles
Coachella Ranches . . . . . Riverside
Codekas, E. J. . . . . Thermal
Collins, A. E. . . . . Yuma, Arizona
Conroy, Mrs. Jessie B. . . . . Indio
Cook, R. E. . . . . Indio
Cook, W. W. . . . . Indio
Cosgrove, Robert S. . . . . Indio
Crommelin, Mrs. J. B. . . . . Palm Springs
Curran, Ed. . . . . Indio

Darley, E. F. . . . . Riverside
Darnell, W. G. . . . . Brawley
Da Vall, E. K. . . . . Cathedral City
Davis, Dr. E. F. . . . . Los Angeles
Desert Garden Date Shop . . Palm Springs
Dillman, R. S. . . . . Yuma, Arizona
Downing, A. P. . . . . Brewton, Alabama
Drury, Dr. Galen . . . . . Oakland
Dunlap, D. D. . . . . Long Beach

Echols Ranch . . . . . Thermal
Embleton, Tom W. . . . . Riverside
Enochs, T. M., Jr. . . . . Coachella
Ensign Ranch . . . . . Borrego

Farrar, E. Keith . . . . . Indio
Fulton, Mrs. Gladys . . . . . Indio
Furr, J. R. . . . . Indio

Garden of the Setting Sun . . . . Mecca
Gerke, H. Sunny . . . . . Los Angeles

Hagberg, A. E. . . . . Yuma, Arizona
Heiny, Frances . . . . . Brawley
Higary, M. A. Gawad . . . Orman, Egypt
Hilgeman, Robert H. . . . Tempe, Arizona
Hubble, B. M. . . . . Monrovia
Hunt, Clinton S. . . . . La Quinta
Hutchinson, Lewis J. . . . . Riverside
Hyde, Jay . . . . . Phoenix, Arizona

Jarvis, Eugene C. . . . . Thermal
Jarvis & Gebhardt . . . . . Thermal
Jenkins, W. G. . . . . Indio

Kasparian, Deron . . . . . Coachella

Laflin, Ben T. . . . . Thermal
Laflin, Ben, Jr. . . . . Thermal
Leach, George H. . . . . Thermal
Le Baron, Edgar M. . . . . Mesa, Arizona
Lichty, Kenneth . . . . . Indio
Lindgren, David L. . . . . Riverside
Long's Date Gardens . . . . . Pasadena

Macpherson, Don F. . . . . Indio
Minor, George E. . . . . Indio
Mitchell, Don H. . . . . Indio
Mock, Dr. D. C. . . . . Redlands

Nash, F. C. . . . . Altadena
Newcomb, Albert . . . . . Thermal
Nixon, Roy W. . . . . Indio
North Ontario Dried Fruit Co. . Los Angeles

Pacific Borax Co. . . . . Los Angeles
Panorama Ranch . . . . . Palm Desert
Paradate Packing Co. . . . . Thermal
Peck, Kenneth . . . . . Pasadena
Pinyan, R. A. . . . . Indio
Proctor, Hugh . . . . . Coachella

Reuther, Dr. Walter . . . Orlando, Florida
Richardson, H. B. . . . . Davis
Ripple, Bert W. . . . . Indio
Russel, Robbins . . . . . Redlands
Ryerson, Knowles A. . . . . Davis
Rygg, G. L. . . . . Pomona

Schroeder, C. A. . . . . Los Angeles
Schwab, Ernest M. . . . . Thermal
Schwabacher, A. E. . . . . San Francisco
Sharples, George C. . . . Tempe, Arizona
Shields Date Gardens . . . . . Indio
Smead, Paul . . . . . Indio
Solt, Maure . . . . . Indio
Swingle, Leonhardt . . . . . Indio
Swingle, Dr. Walter T. . Washington, D. C.

Thomas, Mrs. Mary M. . . . . Altadena
Turk, Howard . . . . . Coachella

Vallat, B. W., Sr. . . . . Pacific Palisades
Van Blaricom, R. B. . . . . Coachella
Van Horn, C. W. . . . . Yuma, Arizona
Venus Foods . . . . . Los Angeles
Vincent, Lloyd E. . . . . Riverside

Walker, Dr. Joseph . . . . . Hollywood
Walker, T. W. . . . . Indio
Webb, Mrs. Lena Cooper . . . . Thermal
Webb, Robert W., Jr. . . . . Palm Desert
Winsor, Mulford . . . . Phoenix, Arizona
Wolf, A. F. (Hill Bros.) . . . . New York
Wood, James E. . . . . Phoenix, Arizona

Yost, Leland . . . . . Thermal
Yowell, Hillman . . . . . Indio

Zimmerer, Max M. . . . . Mecca